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## THE SCIENCE OF VISION

**I**N his Presidential Address to the Indian Academy of Sciences at Nagpur, Professor Raman sought to elucidate the functioning of our visual organs and to explain various facts concerning the same which have so far remained unexplained. In particular, he dealt with the subject of the acuity of vision and the very striking variations which it exhibits in various circumstances. The following is a summary of the main features of his Address.

When we wish to observe any object closely, we turn our eyes so as to ensure that the focused image of the object falls precisely on the central region of the retina of both eyes. It is well known that the visual acuity is highest when the image of the object is located precisely on the depression in the retina known as the fovea and the acuity falls off with extreme rapidity when the image moves away from that position. A movement away from the fovea of ten degrees of arc in either direction is sufficient to reduce visual acuity to a fifth of its maximum value, while a displacement of twenty degrees of arc brings it down to a tenth part of the same. Beyond this again, the acuity for daylight vision continues to fall off, but more slowly.

The influence of the intensity of illumination on visual acuity is a matter of familiar experience. The acuity is highest at high illuminations and diminishes at first slowly, and then much more quickly, and becomes a small fraction of its maximum value when the illumination is weak, even when it is well within the daylight range. These changes in the acuity of vision with diminishing illumination become evident, for example, when we seek to read the pages of a printed book by daylight in the late hours of the afternoon when the sun is about to set and before it has actually become dark. The smaller the print, the greater is the difficulty felt in recognising the letters on the page.

If the finest detail of the object under observation is to reveal itself to our perceptions, it is evidently necessary that well-defined optical images of the object should be formed on the retina of our eyes. This condition, of course, is not satisfied in the case of persons with defective vision. But since such defects can in many cases be rectified by appropriate measures, we need not here consider such situations, but may proceed on the basis that the observer has normal vision, in other words, that the image on the retina has the maximum degree of perfection allowed by optical theory.

Even when a perfect optical image is formed on the retina, it is evident that the detail contained in it cannot be perceived unless the retina itself contains an immense number of elementary structures or receptors which can transmit the details of the image through the optic nerves to the visual cortex in the brain. The more numerous these receptors are and the more closely they are packed, the more accurately we can expect the details of the image to be passed on to the visual cortex and made available for perception. In other words, the fine structure of the retina including especially the number and sizes of the cones and the manner in which they are placed relative to each other in the mosaic of the retina determine the possible acuity of vision.

Anatomical studies have shown that the depression in the retina which constitutes the fovea which has an area of between one and two square millimetres contains over a hundred thousand cones. They are closely packed into a solid formation without any gaps. The entire formation resembles an evenly distributed mosaic. The smallest cones in the mosaic appear around its very centre and the cones gradually increase in size from these outwards to the periphery. The individual cones are mostly hexagonal in shape. They are very thin and of

elongated shape and stand up vertically with respect to the retina at the very centre where they are most crowded together. In that region they are about a thousandth part of a millimetre in diameter. Their size increases as we proceed outwards from the centre towards the periphery of the fovea. The distance between adjoining cones widens as we proceed outwards from the fovea and becomes as much as three, four or even five thousandths of a millimetre towards the periphery of the retina.

These features of the retinal structure enable us to understand in general terms why the visual acuity diminishes rapidly as the optical image of external objects is shifted outwards from the very centre of the fovea to the peripheral regions. A significant feature in the organisation of the retina indicated by anatomical studies is that each cone in the retina apparently possesses a private channel of nerve fibres along which it can send its messages to the brain. Unless some such arrangement exists, it is difficult to understand how the confusion in our perceptions which would arise from a superposition of the messages arising from adjoining cones could be avoided.

The foregoing remarks leave the observed dependence of visual acuity on the strength of the illumination unexplained. Such dependence is of a quantitative nature and can be demonstrated with the same technique as that used by ophthalmologists for the examination of defective vision. A chart

containing rows of letters of progressively diminishing size is viewed by the observer from such a distance that the smallest letters can be read when the illumination is adequate. On progressively diminishing the illumination, one line after another becomes blurred and the letters in it cease to be observable. Precise measurements can be made using special forms of test object, as for example two black bars with a white bar between them, the three bars being of equal lengths and equal widths. If with such an arrangement, a grey bar instead of a white bar is set between two black bars, the visibility falls off even more rapidly with diminishing illumination.

The facts set forth above indicate that the dependence of acuity on illumination has a physical origin. Light consists of quanta or indivisible units of energy which can only be perceived when they are absorbed by the retinal receptors and the energy passed on to the visual cortex. The fact that our eyes can adapt themselves to very high levels of illumination indicates that in daylight vision, the retina is not capable of absorbing more than a very small percentage of the number of light quanta falling on it. If, in addition, the retinal illumination is itself of very low intensity, the number of quanta incident on the retina and actually absorbed by it may be insufficient to enable all the cones present in the illuminated area to function effectively and continuously all the time. When such a situation arises, a fall of the visual acuity is inevitable.

#### INDIAN ACADEMY OF SCIENCES: 29TH ANNUAL MEETING

**T**HE Twenty-Ninth Annual Meeting of the Indian Academy of Sciences was held at Nagpur on the 20th, 21st and 22nd December 1963 under the auspices of the Nagpur University. Shrimati Vijayalakshmi Pandit, Governor of Maharashtra and Chancellor of the Nagpur University, inaugurated the session. Mr. Justice S. P. Kotval, Vice-Chancellor of Nagpur University, welcomed the Delegates. Sir C. V. Raman, Nobel Laureate and President of the Academy, delivered the Presidential

Address. The inaugural function was held in a specially erected and decorated spacious shamiana before a distinguished gathering of more than three thousand people which included Fellows of the Academy, Delegates, University and College professors, research workers and students. The three-day session included invited addresses, symposia and public lectures.

In her inaugural address Shrimati Vijayalakshmi Pandit called for utilising the achievements of science to the maximum benefits of



the common people. At the first festival in his welcome address, planned by a national coordination of research with teaching in our educational system, Sir C. V. Raman chose as the subject of his Presidential Address "The Physics of Vapour" in which he expanded his new findings on the quantum theory of vapour. A summary of his address is given on page 1.

At the scientific meeting in Section A, in the forenoon of the second day, 21st December, over which Professor T. W. K. Ford presided, there were three invited lectures. In the opening address Prof. S. S. Bhatnagar spoke on "The Chemistry of Fluorine Compounds". A summary of this address will appear in an ensuing issue of *Current Science*. The second invited address was by Dr. N. Bhargavantham who spoke on "Defects in Crystal Lattices" with special reference to crystals of  $\text{CaO}$  impregnated with different amounts of  $\text{CaO}$ . In the third talk, which was by Dr. K. G. Ramakrishnan on the "Basic Properties of the Metallic State", it was pointed out how the elucidation of the correct model of a metal is facilitated by the study of certain basic properties like the emission and absorption of radiation by metal, thermal conductivity, of metal and superconductivity. Attempts to understand the superconductivity state in the language of classical physics enable us to postulate an ideal reflecting boundary with the help of which it will be possible to explain the basic properties in a simple qualitative way.

In the afternoon session of the second day there was a symposium on "X-rays and Crystal Structure". Dr. S. Ramaseshan opened the symposium with his address on "Some Procedures in the X-ray Crystal Structure Analysis". Using a working model Dr. Ramaseshan demonstrated the various properties of the Patterson function. He next dealt with the methods of recovering a structure if a molecule and its substituent do not form isomorphous crystals. The actual procedure consists of rotating the Pattersons of the two substances, very tedious in different space groups about the origin and finding out the actual coincidence. The second talk was by Dr. R. Ramakrishnan on "Statistical Properties of X-ray Intensities". Mr. Anil Kumar Singh spoke on some instrumentation and structural investigations at low temperatures. Mr. S. Srinivasan spoke on electrical conductivity and the rotation of groups in crystals. The last talk of the symposium was by Dr. S. Srinivasan who presented his results on the X-ray crystal structure studies of potassium oxalate monohydrate and the crystal coordination of water.

There were two invited talks on "The Atmosphere of Planets". The first was by Dr. K. R. Ramanathan, Director, Physical Research Laboratory, Ahmedabad, who spoke on the optical properties of the planetary atmospheres, and the second was by Dr. M. K. Vann Eppu, Director, Astrophysical Observatory, Kodakanal, who spoke on the radio properties of the atmospheres of the planets.

On the third day of the session, 22nd December, the forenoon meeting in Section A started with an invited address by Dr. K. S. Viswanathan of the National Aeronautical Laboratory, Bangalore on "Artificial Satellites". This was followed by a symposium on Spectroscopy over which Prof. R. K. Asundi presided. Opening the symposium Prof. Asundi spoke on the effect of neutron irradiation on the spectral characteristics of uranyl ion with special reference to cerium uranyl nitrate. This was followed by a talk on "A Possible Iodine-Argon Ultra-violet Laser" by Dr. P. Venkateswarlu. Dr. M. R. Palhye spoke on "Spectra of Aromatic Molecules in the Condensed State", and Dr. N. A. Narasimham gave the results of his latest investigations on the spectra of diatomic molecules.

The afternoon session was the scientific meeting under Section B over which Prof. T. S. Sadayappan presided. The first invited talk at this meeting was by Dr. E. S. Narayanan who presented his latest results on "Breeding Experiments for the Evolution of Superior Races of Silkworms".

The symposium on "Problems of Pathogenesis in Plant" opened with the address by Prof. S. S. Bhatnagar on "Microbial Balance and Pathogenesis". This was followed by a talk by Dr. C. B. Sulochana on "Pathogenesis and Rhizosphere Microflora". Dr. R. Kalyanasundaram spoke on "Toxins and Pathogenesis" and Dr. R. S. Balam on "Inclusions under Virus Pathogenesis". At the University Botany Laboratory, Madras, many facets of the problems of soil-borne diseases and virus diseases of plants have been underway for the past more than a decade. The symposium covered some of the new ground emanating from these investigations. (A detailed account of the symposium will appear in *Current Science* shortly.)

There were two public lectures on the evening of the second and the third days. The first lecture was by Dr. S. Ramaseshan on "March towards Absolute Zero". The second lecture on the concluding day of the session was by Sir C. V. Raman on "The Colours of Flowers".

## CRYSTAL STRUCTURE OF GLUCOSAMINE HYDROHALIDES

R. CHANDRASEKARAN AND M. MALLIKARJUNAN

Department of Physics, University of Madras, Madras-25, India

## 1. INTRODUCTION

AS a part of the work on polypeptides, polysaccharides and other compounds of biological interest, detailed structure determination of amino-acids, simple sugars and other related compounds has been undertaken in this laboratory. The compound glucosamine, in the form of its hydrohalides, was one such taken up for study. A tentative structure had been proposed for the hydrobromide by Cox and Jeffrey<sup>1</sup> in a short note. They had given a set of co-ordinates claimed to have an accuracy of 0.08 Å.

Sometime back, the compound glucosamine hydrochloride was taken up with a view to determine its absolute configuration.<sup>2</sup> The co-ordinates given by Cox and Jeffrey had been used during this work. The results showed that a few of the signs for the observed Bijvoet differences were opposite to those calculated using these co-ordinates. Further, on calculating bond distances, using the data of Cox and Jeffrey, it was found that a few bond distances were short, e.g.,  $C_1 - O_5 = 1.35$  Å,  $N_2 - H \dots O_4' = 2.46$  Å. So also, the position of atom  $O_6$  seemed to be doubtful, as  $C_6 - O_6$  comes out to be as short as 0.85 Å. In view of these it was felt necessary to reinvestigate the structure.

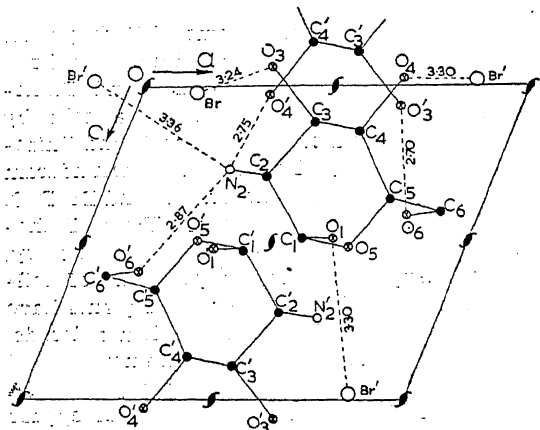


FIG. 1. Projection of the structure of glucosamine hydrobromide on (010). The hydrogen bonds are also given for the atoms in one molecule.

The structure of glucosamine hydrobromide has now been determined completely and it is found that a reorientation is necessary for the primary alcohol group  $CH_2-OH$  in the structure

proposed by Cox and Jeffrey. The co-ordinates of the other atoms have also been refined.

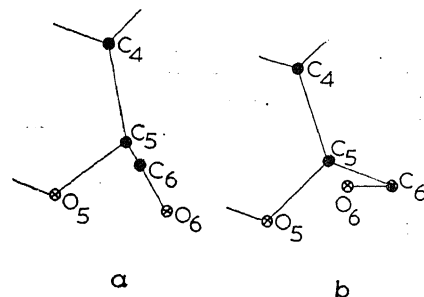


FIG. 2. Comparison of the configuration of the  $CH_2-OH$  group according to: (a) Cox and Jeffrey; (b) the present investigation.

At the time of preparing this note, the reliability indices for two projections stand at  $R(h\ 0\ l) = 0.122$  and  $R(h\ k\ 0) = 133$ . The structure is actually being refined three dimensionally and a detailed report will be published in due course.

## 2. EXPERIMENTAL

The two compounds glucosamine hydrobromide and hydrochloride are isomorphous and belong to the monoclinic system. The cell dimensions are

Formula	a	b	c	$\beta$
$C_6H_{13}O_5N \cdot HBr$ ..	7.96	9.29	7.18	$112^\circ 35'$
$C_6H_{13}O_5N \cdot HCl$ ..	7.68	9.18	7.11	$112^\circ 29'$

They belong to the space group  $P2_1$  with two molecules in the unit cell.

As the report of Cox and Jeffrey did not contain tables of structure factors, it was felt worthwhile to collect intensity data. Complete 3-D data were collected for the layers  $hkl$ ,  $k=0$ , 1, 2, 3, 4; 5 and 6 and  $hk0$  using  $CuK\alpha$  radiation. The  $\lambda$ -equi-inclination Weissenberg technique using the usual multiple films was employed for this purpose. The intensities were measured visually and corrected for Lorentz and polarisation factors and were placed on an absolute scale using Wilson's method.

## 3. STRUCTURE DETERMINATION

A Patterson map was first drawn for the centrosymmetric  $b$ -axis projection and this gave the bromine position ( $x = 0.14$ ,  $z = 0.02$ ) close to that assigned by Cox and Jeffrey. A structure factor calculation for this projection

using the reported co-ordinates gave an  $R$ -index of 0.29. A difference-Fourier was drawn using the difference between observed and calculated structure factors as coefficients. In the map, the position assigned by Cox and Jeffrey for  $O_6$  ( $x=0.91$ ,  $z=0.50$ ) turned up in a deep negative region of density  $\sim 7 e/A^2$ . There was also a significant positive peak of height  $\sim 5 e/A^2$  in its vicinity ( $x=0.91$ ,  $z=0.40$ ). The atom  $O_6$  was therefore shifted to this position. The other atoms were also shifted according to the slopes of the electron density at their assumed sites. The  $R$ -index came down to 0.21 indicating that the shift of the atom  $O_6$  was significant. Another difference-Fourier was drawn at this stage and it showed anisotropic thermal motion for the bromine atom. The anisotropic thermal motion was first corrected for and the  $R$ -index dropped to 0.186. It was also observed in the same map that  $C_6$  was at a positive peak of density  $\sim 1 e/A^2$  while  $O_6$  was at a negative peak of strength  $\sim 2 e/A^2$  suggesting a possible interchange of these two atoms as far as the projection was concerned. Such an interchange was actually found plausible stereochemically since a three-dimensional model with  $C_6$  and  $O_6$  interchanged showed the formation of a good hydrogen bond of the type  $O_6-H\cdots O_3$ . A third difference-Fourier was drawn at this stage and it indicated, as in the previous map, the need for the interchange of atoms  $C_6$  and  $O_6$ , together with small shifts for the other atoms. When a structure factor calculation was carried out incorporating these changes, the  $R$ -index appreciably fell to 0.136 and another cycle of difference-Fourier refinement brought down the  $R$ -index for the  $h0l$  reflections to 0.122.

At this stage, the  $y$ -co-ordinates were fixed from the model and bond length considerations. A structure factor calculation for the  $hk0$  reflections gave an  $R$ -index of 0.133. The co-ordinates of all the atoms at this stage of refinement are given in Table I and a  $b$ -projection of the structure is shown in Fig. 1. Calculations show that the bond lengths are satisfactory. The hydrogen bond system is also satisfactory and all the hydrogen bond lengths and angles are within the usual limits. No abnormal short contacts are observed in the structure.

The main difference between the structure proposed by Cox and Jeffrey and the one

described here is indicated in Fig. 2, where the atoms  $C_4$ ,  $C_5$ ,  $O_5$ ,  $C_6$ ,  $O_6$  are shown. It will be noticed that, in the projection, the present position of  $O_6$  coincides closely with the position  $C_6$  in Cox and Jeffrey's structure, while there is no atom in the position of  $O_6$  as given by them. The latest difference-Fourier does not show any peak at the position of  $O_6$  given by them and therefore no atom can be present in that position. Probably this explains the observation of Cox and Jeffrey that "the primary alcohol oxygen atom...has not emerged quite so definitely from the Fourier synthesis".

TABLE I

Fractional co-ordinates (glucosamine hydrobromide)

Atom	$x$	$y$	$z$
$C_1$	0.5700	0.3637	0.4800
$C_2$	0.4100	0.3314	0.2850
$C_3$	0.4800	0.3314	0.1100
$C_4$	0.6050	0.2001	0.1400
$C_5$	0.7600	0.2001	0.3550
$C_6$	0.9050	0.0818	0.4000
$O_1$	0.6500	0.5089	0.4850
$N_2$	0.3050	0.4638	0.2650
$O_3$	0.3100	0.2991	0.9400
$O_4$	0.6650	0.1851	0.9750
$O_5$	0.7000	0.2410	0.5100
$O_6$	0.8200	0.9480	0.4100
Br	0.1400	0.0000	0.0200

A three-dimensional structure factor calculation was carried out using the co-ordinates in Table I and this gave  $R$ -index of 0.148 for the 900  $hkl$  reflections, including 60 unobserved reflections. If the unobserved reflections are omitted, the  $R$ -index is 0.142. A 3-D least-squares refinement of the structure is in progress.

The isomorphous compound glucosamine hydrochloride is also being refined using 3-D data.

We are indebted to Professor G. N. Ramachandran, Dr. R. Srinivasan and Dr. K. Venkatesan for useful discussions. One of us (R. C.) is grateful to the Government of India for the award of a Scholarship which enabled this work to be done.

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# THE WOOD ANATOMY AND THE TAXONOMIC POSITION OF SONNERATIACEAE

J. VENKATESWARLU AND P. S. PRAKASA RAO  
Department of Botany, Andhra University, Waltair

**E**XCEPT for brief and generalised descriptions<sup>5-10</sup> of the secondary xylem of the genera *Sonneratia* and *Duabanga* heretofore, no systematic approach to the family on the basis of wood anatomy has been endeavoured. The present communication concerns the study of the secondary xylem of *Sonneratia apetala* Ham., *S. acida* Linn. and *Duabanga sonneratioides* Ham.

Table I presents the summary of the pertinent anatomical features found in the woods under study.

oblique, but usually intermediate (Figs. 4, 5). Perforation plates are exclusively simple. The vessel-member lengths in the specimens surveyed range from moderately short to medium-sized in *Sonneratia* and moderately long in *Duabanga*. The vessel segments are truncate or attenuately tailed. Inter-vessel pitting is profuse; the pits are of medium size, circular, predominantly alternate (Figs. 4, 5) and definitely vested. The vessel-ray pits (Figs. 7, 8, 9) are of two types: (a) somewhat

TABLE I  
Summary of the pertinent anatomical features of the woods investigated

Specimen	Pore distribution per mm.	Pore arrangement			Vessel diameter (range in microns)	Vessel element length (range in microns)	Parenchyma	Fibre and fibre tracheid length (range in microns)	Fibre wall thickness (in microns)	Ray height in cells
		Singles	Radial multiples	Aggregates						
<i>S. apetala</i> ..	20-25	40	58	2	120-160	300-800	..	700-1000	3-7.5	1-20
<i>S. acida</i> ..	20-29	45	53	2	120-160	275-750	..	750-1100	3-6.0	1-15
<i>D. sonneratioides</i> ..	2-8	45	49	6	125-230	890-1100	Present	750-1025	3.5-0	1-20

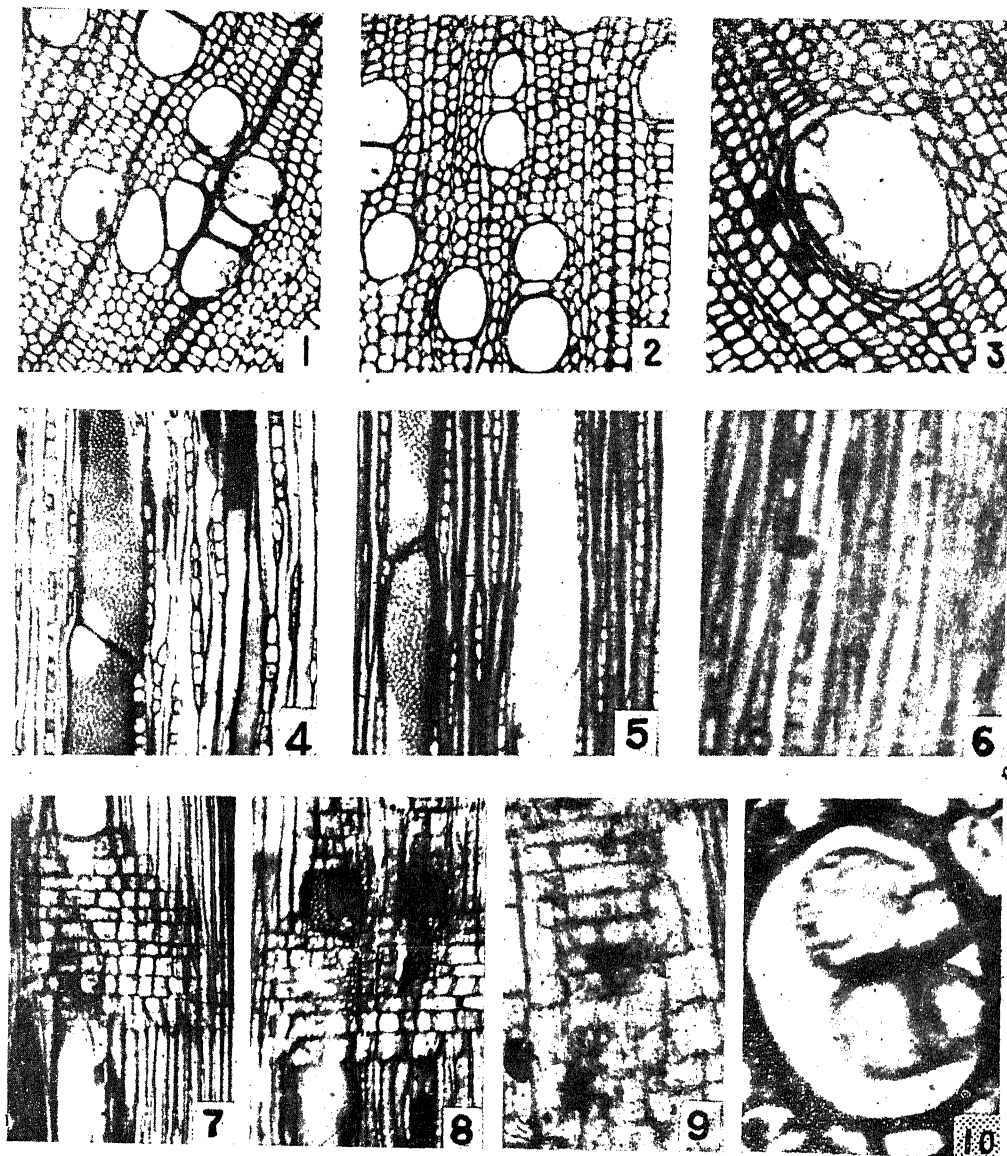
The growth rings are present in all the specimens worked out and are easily discernible by hand-lens, although they look ill-defined to the naked eye. The woods are exclusively diffuse porous (Figs. 1, 2, 3). The vessels are distinct in *Duabanga* and barely visible to the naked eye in both the specimens of *Sonneratia* and are being fairly uniformly spaced within the growth ring without much variation in size. The number of pores per square millimeter are numerous in *Sonneratia* species and few to moderately few in *Duabanga*. The vessel distribution is both in radial groups of 2 to 3 and in singles (Figs. 1, 2, 3) and very occasionally in aggregates. The isolated pores are strikingly broadly oval to circular and those in groups are decidedly flattened in outline. The thickness of the vessel-wall ranges from 2-10  $\mu$  and most show thickness between 2 and 5  $\mu$ . The tangential pore diameters are medium-sized in *Sonneratia apetala* and *S. acida* and moderately large-sized in *Duabanga*. The slope of the end-walls in the vessel element shows wide variance and ranges from moderately horizontal to very

large, flattened, few in number for the field, gash-like and often extending almost the width of the cross-field in scalariform arrangement and (b) very minute, generally more in number and oval to round in shape. The two types associated with the intermediates sometimes do occur in the same cell. The pits are simple to narrowly bordered. The vessels usually are open but at some places their cavities are occluded with dark gummy or tanniferous material. Tyloses occur very abundantly in *Sonneratia apetala* and *Duabanga* (Figs. 1, 3) and very sparsely in *S. acida*. They are variable in size, spherical to sub-spherical and occur either in singles or in close clusters within the vessel element. Mostly they are thin-walled, but in *Sonneratia apetala* a low percentage of them are thick-walled with ramiform pitting (Fig. 10).

The occurrence of axial parenchyma is restricted to the genus *Duabanga* alone and it is predominantly paratracheal forming one to three cells thick vasicentric sheaths around the vessel members (Fig. 3).

The fibres constitute the most part of the ground tissue of the wood. They are semi-libriform, polygonal in cross-section and aligned in regular radial seriations. They are short to

moderately long and are both septate and non-septate in *Sonneratia* species (Figs. 4, 5) and exclusively non-septate in *Duabanga* (Fig. 6). The pits to fibres are few to many, minute and



FIGS. 1-10. Fig. 1. *Sonneratia apetala*. Cross-section showing diffuse-porosity, vessel distribution and tyloses in the vessels. Fig. 2. *S. azida*, cross-section to show diffuse porosity and pores in solitary and radial multiple arrangement. Fig. 3. *Duabanga sonneratioides*, cross-section to show diffuse-porosity, paratracheal parenchyma in vasicentric sheaths and tyloses in vessel element. Fig. 4. *S. apetala*, tangential section to show the fibrous elements, uniseriate rays; inter-vessel pitting and vessel element end-walls. Fig. 5. *S. azida*, tangential section showing non-septate fibres and uniseriate rays. Figs. 7-8. *D. sonneratioides*, radial section showing ray-vessel pitting. Fig. 9. *D. sonneratioides*, radial section showing ray-vessel pitting. Fig. 10. *S. apetala*, cross-section showing the vessel element with tyloses. Figs. 1-9,  $\times 72$ ; Fig. 10,  $\times 950$ .

simple to bordered. Panshin<sup>9</sup> also records bordered pits in the wood fibres of *S. caseolaris*. The bordered pits usually exhibit round apertures, but the occurrence of crossed apertures in the bordered pits of the fibres is not infrequent. Janssonius<sup>6</sup> notes a distinct type of fibre cells around the vessels in *Sonneratia* and these are distinguished from the rest in that they are shorter, thin-walled and rounded with untapering ends leaving intercellular spaces in between them. Brown,<sup>2</sup> however, doubts if such distinction can be made in the Indian species, although he records some markedly shorter fibres with blunt ends in *Duabanga*. Such fibre cells were, in fact, recorded by the authors in both the species of *Sonneratia* and these fibre cells resemble the normal ones except that they are quite narrow. Those reported by Brown are not present in *Duabanga*.

The vascular rays are indistinct to the naked eye. They are numerous, narrow and closely distributed. They are usually uniseriate (Figs. 4, 5, 6) and only very occasionally do we come across biseriate and triseriate conditions in these taxa. They correspond to Kribs<sup>7</sup> homogeneous Type III in *Sonneratia* species as opposed to the heterogeneous condition reported by Pearson and Brown.<sup>10</sup> *Duabanga*, however, displays heterogeneous rays of Type III. The height of rays in cells ranges from 1-20, 1-15 and 1-20 in *S. apetala*, *S. acida* and *D. sonneratioides* respectively. In general, the ray cells are made up of short procumbent cells of varied sizes and shapes apart from the row of crystalliferous cells in the species of *Sonneratia*. The ray cells are thin-walled and bear very few, minute and oval to rounded simple pits. In *Sonneratia* species certain of the ray cells bear dark brownish-black gummy deposits.

From these studies it is quite evident that the woods display an assemblage of features which signify primitiveness as also moderate phyletic advancement. These characters are: the presence of both fibre-tracheids and semi-libriform wood fibres; the length of the fibrous elements being very short to medium-sized; the predominance of oval or circular thin-walled vessel elements; vessel elements ranging from short to moderately long but averaging to medium size; predominance of vessel elements with simple perforation plates; occurrence of at least a low percentage of vessel elements with almost transverse end walls; exclusively alternate inter-vessel pitting; vascular rays mostly uniseriate and which are either homogeneous or heterogeneous and, finally, the

presence of paratracheal parenchyma of vasicentric type. These features of secondary xylem suggest that sonneratiaceous members are somewhat specialised taxa of the angiosperms.

From a close comparison of the sonneratiaceous woods with those of the putatively related families it becomes clear that they share in common the highly specialised characters, namely, simple perforation plates, alternate intervascular pitting but differing from one another in one or more features like the nature and distribution of parenchyma, nature of the fibres, presence and absence of vested pits and in the nature and type of vascular rays. It is only Lythraceae among the families of Myrtiflorae that shows most features in common with Sonneratiaceae, namely, small to medium-sized vessels; vessel elements with simple perforation plates; numerous intervascular pits which are predominantly alternate, bordered and vested; wood fibres libriform and septate; vascular rays nearly always uniseriate and heterogeneous to homogeneous and parenchyma distributed paratracheally when present. Besides these similarities in the secondary xylem, both the genera, as has already been shown by Venkateswarlu,<sup>12</sup> agree in their embryological features with those of the Lythraceae. Erdtman,<sup>4</sup> while describing the structure of the mature pollen grains of Lythraceae, writes: "The grains in *Diplusodon* and *Pemphis* (less so those in *Galpinia*) have some characters in common with the Sonneratiaceae. The latter family was previously (and more correctly?) referred to Lythraceae." Further the following morphological traits are held in common among these two familial taxa: (1) arborescent habit, (2) simple, exstipulate leaves, (3) entirely bisexual actinomorphic flowers, (4) presence of calyx-tube, (5) presence and absence of petals and (6) seeds non-endospermic. Thus from the available evidence (embryological, xylotomical, palynological and morphological) it can at once be seen that *Sonneratia* and *Duabanga* show most features in common with Lythraceae. There are, however, a few distinct differences in morpho-anatomical features between the genera *Sonneratia* and *Duabanga* on the one hand and between the two genera and the Lythraceae on the other. In the light of these observations it appears that erection of a separate family Sonneratiaceae,<sup>3,5-11,13</sup> with only these two genera included in it, is not justified. Therefore the two genera *Sonneratia* and *Duabanga* may be brought under the family Lythraceae as proposed

by Bentham and Hooker<sup>1</sup> and treat them as members of separate subfamily Sonneratioidae within Lythraceae.

The authors are thankful to the Officer-in-Charge, Forest Research Institute, Dehra Dun, for providing wood samples of materials used in this study.

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## OURSELVES

WE are glad to announce that beginning from this number *Current Science* will appear as a Fortnightly instead of as a Monthly as hitherto, and will be issued on the 5th and 20th of each month.

*Current Science* as the first Journal to be published in India, which is devoted to all branches of scientific research, has been enjoying a position of importance amongst science journals not only in our country but also elsewhere in the world.

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EDITOR.

## LETTERS TO THE EDITOR

THE ULTRASONIC EFFECT ON THE  
ULTRA-VIOLET ABSORPTION  
SPECTRUM OF BENZENE VAPOUR

It is well known that the absorption of ultrasound is due not only to viscosity and heat conduction but also to intramolecular action which gives rise to dispersion. More than one such region of velocity dispersion may be encountered in a single molecule. These dispersions result from a failure of some internal mode of motion of the molecule to equilibrate with the temperature fluctuations of the sound wave.<sup>1</sup> The temperature changes first affect the translational degrees of freedom; any temperature change in these is followed by a relatively slow process of equalization with the internal degrees of freedom. Such slow exchange of energy, particularly between internal and external degrees of freedom, is a relaxation phenomenon.

If during the relaxation period, the relative change in density is too small the processes responsible for the energy exchange will keep the two degrees nearly in equilibrium. The total energy converted into heat motion will be divided between the two, and the temperature rise will be governed by the static specific heat. The latter, however, can be divided into two parts: one belonging to the external degrees, the other to the internal degrees. If the rate of density change is increased (e.g., frequency of sound wave) the internal energy can follow the changes of external energy less and less and, accordingly, "the effective specific heat" decreases. If the density changes are rapid compared to the adjustment process, only the energy of the external degrees of freedom varies, and the effective specific heat is that of external degrees alone.

It is experimentally proved that the binary molecular collisions alone cause the energy transfer. Hence, as long as the gas is ideal, dispersion and absorption per wavelength depend, at a given temperature, only on the ratio of frequency to pressure. The ratio of experimental to classical absorption at low frequency is independent of frequency and pressure and depends only on the number of collisions needed to produce equilibrium between internal and external energy and the specific heats

involved. The changes in specific heat involve changes in vibrational contributions caused in turn by changes in internal modes of vibration. When the changes in vibrations take place, the frequencies of the fundamentals and different combination tones get altered. Consequently, a shift in the position of the corresponding absorption bands of the molecules may be expected when the absorbing medium is traversed by an ultrasonic beam of appropriate frequency.

The ultra-violet absorption spectrum is studied for this effect for the first time. The present investigation is on the absorption spectrum of benzene vapour<sup>2</sup> corresponding to electronic transition  ${}^1A_{1g} - {}^1B_{2g}$  occurring at 2600 Å. The ultrasonic beam is passed in a direction nearly perpendicular to that of the light path through a quartz crystal. The frequencies of the ultrasonic waves chosen are 0.9, 2.7 and 4.5 Megacycles/second and pressure of the vapour ranged from 1–27 cm. of mercury. In the first instance, the observations are confined to the bands relating to modes of vibration having the frequencies 695, 608, 205, 526 and 1483; the first two occur on the red of (0, 0) and correspond to lower state while the last three on the violet and so to upper state. Figure 1 shows the effect on the intense band

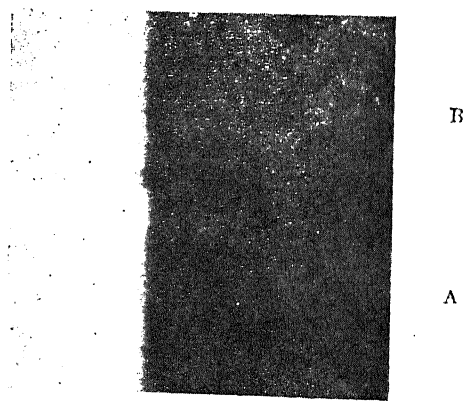
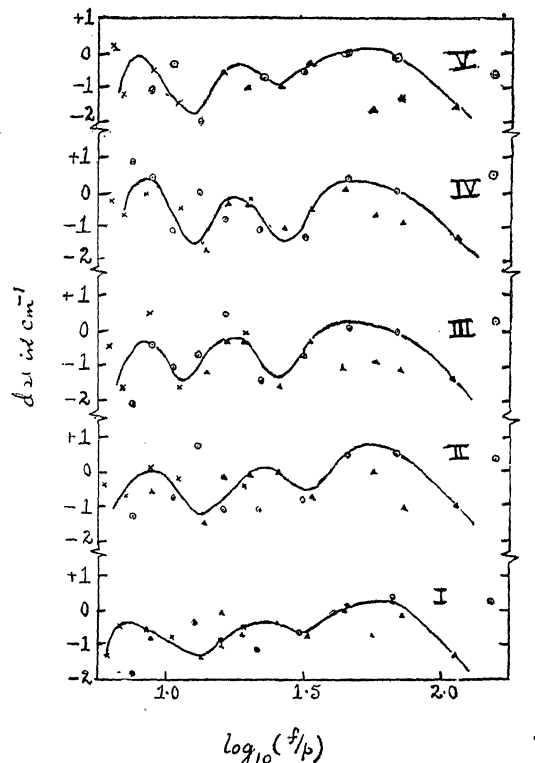


FIG. 1. Plate of the absorption band  $38615\text{ cm}^{-1}$  (upper state vibration,  $526\text{ cm}^{-1}$ ). (A) Absorption band subjected to ultrasonic beam; (B) Ordinary absorption band.

$38615\text{ cm}^{-1}$  (upper state  $526\text{ cm}^{-1}$ ). The shift observed is  $1.3\text{ cm}^{-1}$  to the red side of the



ordinary absorption band at  $f/p = 30.75$  Mc. sec<sup>-1</sup> atmos.<sup>-1</sup>. The measured shift is accurate up to  $\pm 0.25$  cm.<sup>-1</sup>



× ○ 5.9 Mc./Sec.    ○ 2.7 Mc./Sec.    ▲ 4.5 Mc./Sec.

FIG. 2. Plot of  $d\nu$  vs.  $\log_{10}(f/p)$

- |                                 |                        |                |
|---------------------------------|------------------------|----------------|
| I. (37394 cm. <sup>-1</sup> )   | 695 cm. <sup>-1</sup>  | } Lower state. |
| II. (37481 cm. <sup>-1</sup> )  | 608 cm. <sup>-1</sup>  |                |
| III. (38294 cm. <sup>-1</sup> ) | 205 cm. <sup>-1</sup>  | } Upper state. |
| IV. (38615 cm. <sup>-1</sup> )  | 526 cm. <sup>-1</sup>  |                |
| V. (39372 cm. <sup>-1</sup> )   | 1483 cm. <sup>-1</sup> |                |

A plot of the band shift  $d\nu$  cm.<sup>-1</sup> vs.  $\log_{10}(f/p)$  where  $f$  is the frequency of the ultrasonic waves in megacycles per second and  $p$ , the pressure of the vapour in atmospheres, shows three absorption maxima. The lowest absorption maximum is in agreement with the maximum obtained by Cheng<sup>3</sup> in the plot of molecular absorption coefficient per wavelength vs.  $\log_{10}(f/p)$ , using ultrasonic interferometer at the temperature 30°C. The appearance of the other two absorption maxima may be explained by a parallel excitation process (Schaefer)<sup>4</sup> of at least three modes of vibration.<sup>5,6</sup>

Physics Department, V. VENKATA SESHIAH.  
S.V. University, S. V. SUBRAHMANYAM.  
Tirupati (A.P.), India, K. SREE RAMA MURTY.  
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### DRIFT AND ANISOTROPY OF THE IRREGULARITIES IN THE LOWER F-REGION UNDER MAGNETICALLY ACTIVE CONDITIONS

CORRELATION analysis of Briggs *et al.*<sup>1</sup> and Phillips and Spencer<sup>2</sup> has been applied to the fading records obtained by the spaced receiver method of Mitra<sup>3</sup> on a magnetically disturbed day (28-10-1961), with a view to study the effect of magnetic activity on the drift and anisotropy characteristics of the irregularities in the lower F-region. Observations are available for three different levels of which the lower level of 175 km. is represented by an average value of three independent observations pertaining to that level. Results of the drift and anisotropy characteristics for the three levels, the true heights of which are deduced from manually taken  $h'f$  records by Schmerling's<sup>4</sup> five points method, are presented in Table I along with the corresponding values of the parameters for magnetically quiet conditions obtained from nine sets of observations taken on different days. A detailed comparison has been made of the results presented in this table with a view to study the effect of magnetic activity on the various parameters.

It can be seen from Table I that the true drift speed  $v$  is found to decrease and the apparent drift speed  $v_a$  is found to increase with magnetic activity. The true drift speed is found to increase with height continuously on quiet days whereas for disturbed days it shows a maximum at 200 km. and decreases on either side. The variation of the apparent drift speed with height is, however, found to be similar for both disturbed and quiet conditions.

The characteristic velocity  $V_c$  is found to increase considerably with magnetic activity at the level of 200 km. and decrease at levels below and above 200 km. The variation of  $V_c$  with height is found to be similar to that of  $V$  for disturbed conditions exhibiting a maximum at 200 km. while for quiet conditions  $V_c$  is found to decrease with height. The increase with

TABLE I  
Drift and anisotropy parameters for magnetically quiet and disturbed days

h in km.	$v (=V/2)$ in m./sec.		$v_a (=Va/2)$ in m./sec.		$\phi$ in deg. E of N		$\phi_a$ in deg. E of N		$a$ in metres		$r$		$\theta$ in degrees		$V_c$ in m./sec.		$V_c/V$	
	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.	Quiet	Dist.
175	80	62	100	122	252	232	240	239	330	364	2.22	1.8	27	21	158	128	0.99	1.03
200	84	79	121	127	246	223	250	270	419	630	2.35	2.6	21	16	153	188	0.9	1.2
230	100	66	76	85	213	309	231	270	356	294	2.6	2.1	20	24	132	100	0.66	0.76

magnetic activity of the random change factor  $V_c/V$ , a measure of random changes relative to pure drift in causing fading, is found to be not appreciable, though it is a little more for the level of 200 km.

The true and apparent drift directions  $\phi$  and  $\phi_a$  lie mostly in the SW quadrant for both quiet and disturbed conditions. The variation of  $\phi$  with height reveals the drift vector to be rotating anti-clockwise sense in the region below and clockwise sense in the region above the level of 200 km. for disturbed conditions, while for quiet conditions the rotation of the vector is consistently anti-clockwise in the height range of investigation.

From a study of the anisotropy characteristics of the characteristic ellipse of 0.5 correlation, it appears that the length of the semi-major axis ' $a$ ' is more for disturbed conditions at the levels of 175 and 200 km., the increase with magnetic activity being highest for the latter. The length of the semi-major axis varies with height exhibiting a maximum at 200 km. which is very prominent on disturbed days compared to quiet days. The axial ratio ' $r$ ' increases continuously with height on quiet days whereas on a disturbed day it shows a maximum at 200 km. From a study of the average inclination ' $\theta$ ' of the major axis with NS direction it can be said that the irregularities align with their major axis very close to the NS direction for both disturbed and quiet conditions. The values of  $\theta$  presented for the three height levels reveal that the irregularities are more closer to NS direction at the level of 200 km. for disturbed conditions whereas for quiet days the irregularities tend to be more closer to the NS direction at higher levels.

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Dept. of Physics, P. BALARAMA RAO.  
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#### THIN LAYER CHROMATOGRAPHY IN THE ANALYSIS OF BLASTING EXPLOSIVES

BLASTING explosives contain nitrates of glycerine and/or glycol in addition to other materials like nitrocellulose, etc. In view of the simplicity, small amount of the sample and less time (as compared to other methods) required, thin layer chromatography has been applied to the separation and identification of the different nitrate esters of glycol and glycerol.

Chromatographic plates were prepared by coating one side of glass plates (24 × 4 cm.) manually with a thin layer of silicic acid (E. Merck's reagent grade, silica gel-fine for partition chromatography) plaster of paris (9:1) mixture as per standard procedure.<sup>1</sup> After drying overnight at room temperature the plates were activated at 110° for 1 hour before use.

Suitable aliquots of the ether extract of the explosive and of the ether solution of known mixture were spotted, with the help of a fine capillary, 1 cm. apart on a line about 2 cm. from one end of the plate. The known mixture consisted of glycol dinitrate, glycerol trinitrate, diethylene glycol dinitrate and diglycerol tetranitrate. After evaporating off the solvent, the plates were developed in the usual way with benzene-petroleum ether (1:1) mixture in a suitable glass cylinder (30 cm. high and

5 cm. diam.). The cylinder walls were lined with two filter-paper strips (1 × 30 cm.) dipping at one end into the developing solvent mixture. This will help saturation of the chamber with the solvent vapours and rapid equilibration. Under these conditions a 30-45 minute run was found sufficient for efficient separation of the

glycerol trinitrate and diethylene glycol dinitrate and another with diglycerol tetranitrate and glycerol trinitrate were run. The results are presented in Figs. 1 and 2. It is evident from these figures that the unknown contains glycerol trinitrate and diethylene glycol dinitrate.

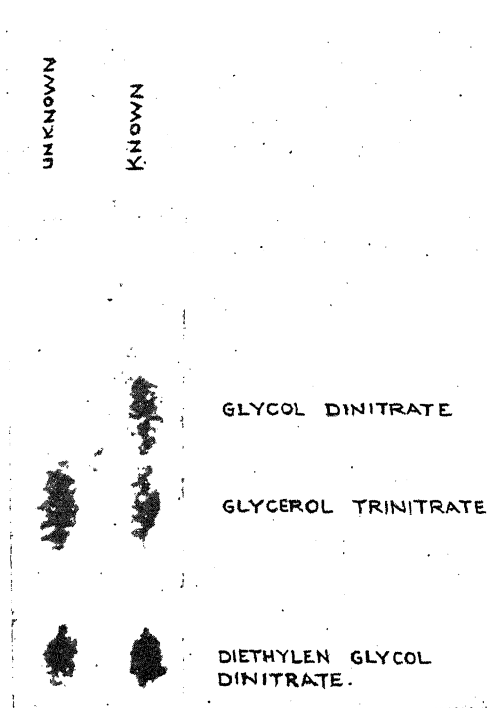


FIG. 1

Fig. 1. Separation of nitrate esters of glycol, glycerol and diethylene glycol.

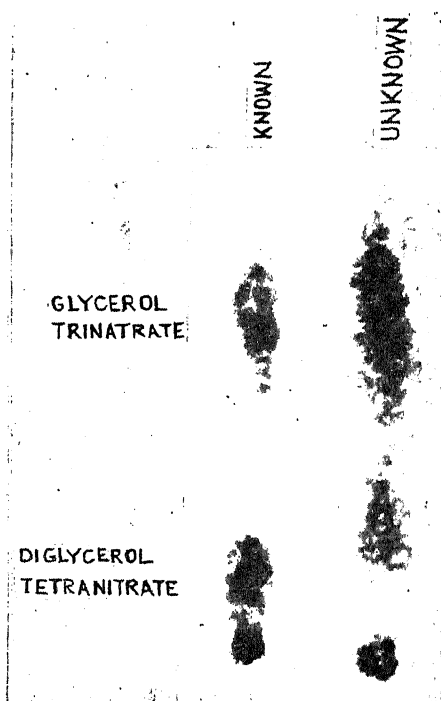


FIG. 2

Fig. 2. Separation of nitrate esters of glycerol and diglycerol.

constituents. At the end of the period, the plates were taken out, dried at room temperature and sprayed with 1% solution of diphenylamine in concentrated sulphuric acid. Blue spots indicated the location of the different esters. The constituents of the known mixture were located and identified by separate individual runs.

It was observed that while glycol dinitrate, glycerol trinitrate and diethylene glycol dinitrate could be clearly separated from one another, complete separation of diglycerol tetranitrate and diethylene glycol dinitrate was difficult by the method followed. So in the present experiment, two separate controls one with the mixture of glycol dinitrate,

This method may probably be very conveniently applied also for the separation of all the four nitrate esters in a single mixture either by the use of a different solvent mixture or by two-dimensional technique. Extension of this method to other constituents of the blasting explosives as well as to propellants and other explosives is being investigated.

Explosives Research and  
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Kirkee, Poona-3,  
July 24, 1963.

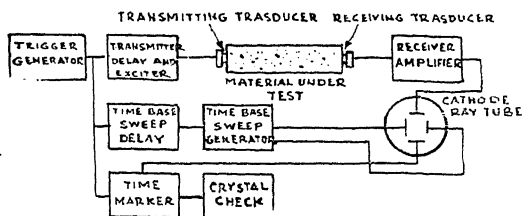
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A. K. BHALLA.  
S. K. SINHA.

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## A NEW METHOD FOR THE DETERMINATION OF "CROSS-FRACTURE" IN SLATES

**DETERMINATION of Cross-Fracture (Sculping) in slates** when it is but faintly shown on the cleavage surface often becomes a difficult task, more so in the field where detailed petrographic testing is not possible. Hence, with a view to devising a field method, slates from the localities of Kund ( $28^{\circ} 9' : 76^{\circ} 27'$ ); Bhetar Dari ( $22^{\circ} 41' : 86^{\circ} 11'$ ) and Kanhiara ( $32^{\circ} 12' : 76^{\circ} 27'$ ) in India, were subjected to various physical and petrographic tests. Results obtained from ultrasonic testing have been found very promising.

Saw-cut slates of size  $5'' \times 2'' \times 2''$  were prepared from the quarry samples. Ultrasonic phase velocities through the specimens were obtained by measuring the time taken by the waves to travel from one end to the other electronically.<sup>1,2</sup> Circuit arrangements of the ultrasonic apparatus for the transmission method used in these experiments are shown by the schematic diagram (Fig. 1). The trigger



**FIG. 1.** Schematic diagram of the ultrasonic pulse tester. generator produces a negative short-duration rectangular pulse at a repetition frequency of 50 pulses/second, the leading edge of which triggers the transmitter delay, time base delay and time marker circuits. The transmitter variable delay unit generator is a rectangular pulse which can be varied linearly over a range of 10 micro-seconds and triggers the transmitter exciter. An ultrasonic pulse, consisting of a train of longitudinal waves, results from the shock excitation of a piezo-electric crystal (barium titanate) transducer which is coupled to the material under test by a thin film of oil. A similar piezo-electric transducer is used to receive the ultrasonic pulse after travelling through the material. The received signal is led through a high gain amplifier to the vertical deflection plates of a cathode-ray tube. The time base sweep delay and the time marker circuits enable one to measure accurately the time taken by an ultrasonic pulse to travel through the known length of the material.

From the data the wave velocity of an ultrasonic pulse in the media has been calculated in ft./sec. in two directions, i.e., along the grain and across the grain. The mean values so obtained are given in Table I.

TABLE I  
*Ultrasonic wave velocities in slates*

Rock	Length	Time in m. sec.	Velocity in ft./sec.	Remarks
Slates ..	5"	20	20,830	Along the grain
Do. ..	2"	12.5	13,330	Across the grain

From the results it has been noted that there are two wave velocities in two directions of the slate grains. Ultrasonic waves travel faster along the direction of grain than across it. Expecting a similar behaviour in case of heat waves travelling along and across the grain direction, the following test was devised and found successful.

The slate is split in a direction parallel to its cleavage and one of the surfaces is made exceedingly smooth by grinding over coarse sand or carborundum powder using water as medium. The smooth surface is covered with an even and very thin coat of a mixture of double iodide of copper and silver in the ratio of 85% and 15% respectively. The solution media for application of these pigments should be alcohol-soluble ureaformaldehyde resins, shellac or gums. The slate is kept flat with coated surface upwards and a pointed flame is then applied from below, i.e., in the centre of the reverse side of the coated surface. As the slate is heated the coated mixture changes its colour from red to almost black. The transition of colour is so well marked that the direction along which the changes are more rapid can be observed without any difficulty. The direction along which the colour changes are more rapid is the direction of "Cross-Fracture" in the case of slates.

Indian Institute of  
Technology, Delhi  
and

P. KUMAR.

University of Roorkee,  
Roorkee,

R. S. MITTAL.

October 12, 1963.

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**ELECTROMETRIC ESTIMATION OF  
CHLORIDE AND LACTOSE**

DURING the studies on the estimation of chloride and lactose in milk by the usual standard official methods, the need to develop a procedure where these two constituents could be estimated simply, but accurately and successively in the same aliquot of the sample, was felt. A few sugars like glucose and fructose<sup>1,2</sup> and some halides like bromide and iodide<sup>3</sup> have been estimated by 'Cerate Oxidimetry'<sup>4</sup> or otherwise called 'Cerimetry'<sup>5</sup> but the estimation of chloride and lactose by this method has not so far been reported. Hence, the new method of 'Cerimetry' was applied to the estimation of chloride and lactose contained in a solution, and this was the first attempt at the simultaneous estimation of these two constituents in the same aliquot sample. The titration was carried out with a 'Transistorized Titrimeter' using appropriate electrodes for the estimation of chloride and lactose in successive steps.

The titrimeter was constructed according to the circuit by Stock<sup>6</sup> with the modification that a millivolt meter was also included to give the two peaks at which chloride and lactose respectively were estimated. This addition further helped in the detection of end-points as indicated by a rise in potential by the 'reversed dead-stop end-point' titrimetry<sup>7</sup> which was more convenient than the usual procedure of observing the fall in current to zero. This procedure involves only one reversible electrode process, the end-point being shown by the potential rising to a maximum from a small residual value.<sup>8</sup> The meter included a variable resistance for applying 'polarising voltage' on one of the identical electrodes during the 'dead-stop end-point' titrimetry. A pair of platinum electrodes was used for the estimation of lactose and platinum-silver electrode combination for the estimation of chloride.

10 ml. of the sample was pipetted out into a 100 ml. flask, which contained about 80 ml. of distilled water, then filled up to the mark with more distilled water and mixed well. 5 ml. of the diluted sample was transferred to a titration cell maintained constant at 37°C., and placed on a magnetic stirrer. 25 ml. of acetone and 10 ml. of 9-M H<sub>2</sub>SO<sub>4</sub> were added and then titrated against standard 0.01-N Ceric ammonium sulphate solution.<sup>9</sup> After the first end-point as seen from the maximum at 150 mV, the same solution was further diluted with 20 ml. of distilled water and the titration was continued against the ceric solution, to the second end-point at the next maximum of 220 mV,

A model solution containing 4.5% of lactose and 0.1% of chloride was used and the two constituents were estimated by the above method. Other constituents like fat, casein, Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>, Mg<sub>3</sub>(C<sub>6</sub>H<sub>5</sub>O<sub>7</sub>)<sub>2</sub> which are normally present in milk were added separately to the model solution in their proper concentrations and the estimations were carried out. Lactic acid which is normally developed in milk and sucrose which is sometimes added as an adulterant in milk were also added to the model solution separately. Ten estimations were carried out in each case and the average titre values in ml. are presented in Table I.

**TABLE I**

*Average titre value in ml. for chloride and lactose*

No.	Constituents	Chloride	Lactose
1.	0.1% chloride <i>plus</i> 4.5% lactose (A)	1.15	2.56
2.	(A) <i>plus</i> 5% fat	.. 1.16	2.57
3.	(A) .. 3% casein	.. 1.16	2.55
4.	(A) .. 2% PO <sub>4</sub>	.. 1.17	2.56
5.	(A) .. 2% citrate	.. 1.16	2.57
6.	(A) .. 2% lactic acid	.. 1.17	2.55
7.	(A) .. 4% sucrose	.. 1.16	2.58

It is seen that all the normal constituents found in milk do not seem to interfere with the estimation of chloride and lactose by the new cerate method. Only in the case of additional sucrose, some of the values seem to be higher than 2.58, presumably due to the hydrolysis of sucrose by H<sub>2</sub>SO<sub>4</sub> present and these hydrolytic products may be oxidised by the cerate solution.

It was also possible to estimate chloride and lactose in as little as 0.5 ml. of the sample.

The authors are thankful to the Director of Dairy Research, National Dairy Research Institute, Karnal, for his keen interest in this work.

Southern Regional Station, C. S. SUDHEENDRANATH.  
D. SETHU RAO.

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### AMINO-ACIDS OF NAHOR SEED OILCAKE

NAHOR (*Mesua ferrea* Linn.) is a widely occurring species of Assam. The Nahor fruit consists of an inner seed with an outer fibrous shell. The percentage composition of the shell, testa and seed is 50, 13.4 and 36.6 respectively. The seed yields a fixed oil to an extent of 75-80%, the utilisation of which has been worked out<sup>1,2</sup> for the preparation of surface-coating compositions. The residual seed-cake is found to be quite rich in proteins. The nature of the proteins has been studied and the amino-acids obtained by hydrolysis of the total proteins have been identified by descending paper chromatography to be cystine, arginine, serine, proline, leucine, isoleucine, methionine, alanine, phenylalanine, hydroxy proline and citrullin. Three additional spots have not been identified.

Nahor seed-cake is extracted thoroughly with petroleum ether to render it free from fat. The fat-free meal analyses to 3.7% of total nitrogen equivalent to about 23% of proteins on the assumption that there does not exist any non-protein nitrogen. An actual isolation analysis<sup>4</sup> of proteins has shown that the proteins comprise albumins (7.6%), globulins (4.9%), glutelins (2.2%) and prolamins (2.3%).

TABLE I

Amino-acid	R <sub>F</sub> -value
1. Cystine	0.06
2. Arginine	0.10
3. Serine	0.17
4. Citrullin	0.18
5. Hydroxy proline	0.21
6. Proline	0.27
7. Alanine	0.28
8. Methionine	0.49
9. Phenyl alanine	0.59
10. Isoleucine	0.61
11. Leucine	0.62

The protein fraction is isolated by extraction with 1% potassium hydroxide for 24 hours at room temperature and subsequent precipitation by addition of a saturated solution of ammonium sulphate after bringing the pH to 4.5 with dilute sulphuric acid (yield, 13-15%). The protein concentrate is washed free of sulphates and hydrolysed with 6N HCl and also with 6N NaOH. Hydrolysates are analysed by descending paper chromatographic method using butanol : acetic acid : water in the ratio of 4 : 1 : 5. The amino-acid chromatograms are developed by spraying with 1% alcoholic solution of ninhydrin. The R<sub>F</sub> values are compared with those obtained for authentic samples of

different amino-acids. The amino-acid composition of the hydrolysate of the Nahor oil-cake proteins is given in Table I.

The authors wish to express their thanks to Dr. B. N. Mitra, Director, for his keen interest in the problem.

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Jorhat, Assam,  
June 24, 1963.

S. B. CHAUDHURI.  
J. N. BARUAH.  
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### PROTEIN CONTENT OF MARINE ALGAE FROM GUJARAT COAST

WITH the rapid increase in world population, the production of foods, especially those rich in proteins, is receiving greater attention. A number of vegetable protein foods from soybeans, peanuts, cotton-seeds, sesame, sunflower-seeds, coconut and others are being used to supplement human and animal diets and large amount of work is being carried out both in India and in other countries to find out new sources of protein foods.

Golueke *et al.*<sup>1</sup> have shown from a consideration of overall sunlight conversion efficiency that the cost of algal proteins is much less compared to those of animal or other vegetable proteins. Marine algae are being used as foods and animal feeds in Japan, Philippines,<sup>2</sup> China and other places<sup>3</sup> and they are shown to contain the same essential amino-acids as those of higher plants.<sup>4-7</sup> The algal proteins, which also include iodine-containing amino-acids, have been recommended for increasing the milk and butter-fat production of dairy cows, for egg production and fattening of swine.<sup>8</sup> An attempt to utilise seaweeds in India, which has a vast coast line rich in the seaweeds, is worth considering. A survey of protein contents of different seaweeds occurring on the Indian coast is therefore essential for the proper utilization of these algae. The present communication gives the protein content of different seaweeds collected from the Gujarat Coast.

The seaweeds after collection were washed with sea-water, then with freshwater and air-dried at room temperature. The moisture content was determined by heating the air-dried algae at 105-110° C. for 5 hours. The crude protein content was calculated from the nitrogen value, estimated by Kjeldahl's method, using

TABLE I  
Protein content of marine algae from Gujarat coast

Sr. No.	Alga	Place	Date of collection	Moisture in the air-dried alga %	Protein in g./100 g. of air-dried alga
CHLOROPHYCEÆ					
1	<i>Boodlea composita</i> (Harv. et. Hook fil) Brand	Okha	11-11-1962	6.90	10.32
2	<i>Chamadoris auriculata</i> Boergs.	Veraval	10-4-1962	6.64	13.67
3	<i>Cladophora monumentalis</i> Boergs.	Okha	23-11-1961	8.35	16.28
4	<i>Codium dworkense</i> Boergs.	Okha	3-2-1962	4.96	7.22
5	<i>Udotea indica</i> A. & E. S. Gepp	Okha	7-5-1962	4.70	13.00
6	<i>Ulva fasciata</i> Delile	Veraval	10-4-1962	16.84	25.48
7	<i>Ulva lactuca</i> L.	Okha	8-4-1962	6.13	7.69
8	<i>Ulva rigida</i> (C. A. Ag.) Le Jolis.	Gopnath	11-11-1961	15.20	22.42
PHÆOPHYCEÆ					
9	<i>Colpomenia sinuosa</i> (Roth.) Derb. et Sol.	Okha	8-3-1962	7.03	6.62
10	<i>Cystophyllum</i> sp.	Veraval	6-5-1962	11.33	11.21
11	<i>Dictyopteris australis</i> Sond.	Okha	3-2-1962	9.10	8.14
12	<i>Padina gymnospora</i> (Kuetz.) Vickers	Okha	11-11-1962	6.70	12.27
13	<i>Sargassum cinereum</i> J. Ag. var. <i>berberifolia</i> Grun.	Sikka	15-6-1961	12.20	9.61
14	<i>Sargassum johnstonii</i> Setch. and Gard.	Okha	13-8-1961	12.82	10.90
15	<i>Sargassum</i> sp.	Okha	13-8-1961	7.35	13.29
16	<i>Sargassum tenerimum</i> J. Ag.	Okha	13-8-1961	4.70	12.14
17	<i>Spathoglossum variabile</i> Fig. et. De Not	Okha	22-11-1961	10.59	15.66
RHODOPHYCEÆ					
18	<i>Acanthophora muscoides</i> (L.) Bory	Porbandar	2-1-1962	11.62	21.83
19	<i>Asparagopsis taxiformis</i> (Del.) Coll. & Herv.	Okha	4-2-1962	8.02	16.19
20	<i>Centroceras clavulatum</i> (C.A. Ag.) Mont.	Okha	3-2-1962	8.96	20.12
21	<i>Scinaia indica</i> Boergs.	Okha	22-11-1961	11.51	12.51

the conversion factor of 6.25. The data are presented in Table I.

Pillai,<sup>9</sup> while working on the seasonal variation of eight species of algae from Mandapam Coast, reported that protein content did not exceed 12.5%. Chidambaram and Unny<sup>10</sup> also found the protein content to be less than 10% for *Sargassum*, *Gracilaria* and *Turbinaria* species, collected from Madras. On the other hand, Lewis and Gonzalves<sup>11</sup> observed that most of the twelve different algae collected from Bombay Coast had protein content higher than 28%. The algae collected from Gujarat Coast, reported in this paper, also showed a higher percentage of proteins. These results indicate that algae from the West Coast of India are richer in proteins than those collected from South-East Coast. It is also noticed that in general Phaeophyceae contains smaller quantities of protein than Chlorophyceae and Rhodophyceae.

Coulson<sup>12</sup> reported the extraction of proteins from three main classes of marine algae and also a large-scale extraction of proteins from *Rhodymenia palmata*, in which he found the maximum percentage of protein (about 16.9%). In the present study *Ulva fasciata*, *Ulva rigida*, *Acanthophora muscoides* and *Centroceras clavulatum* are found to contain a higher percentage of protein (20-26%) and hence these may be used for the extraction of proteins.

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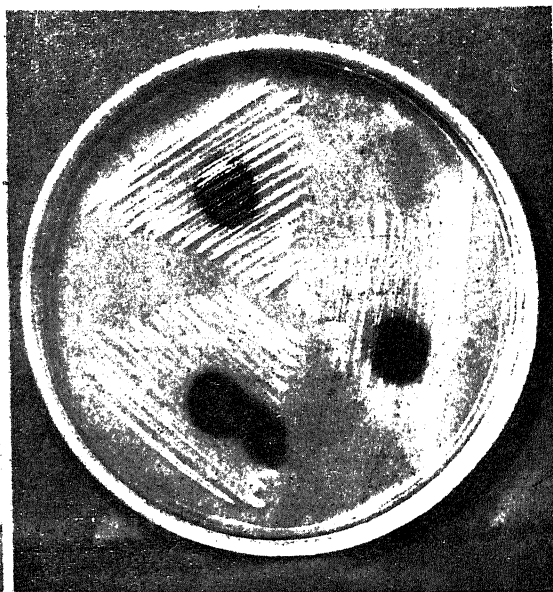
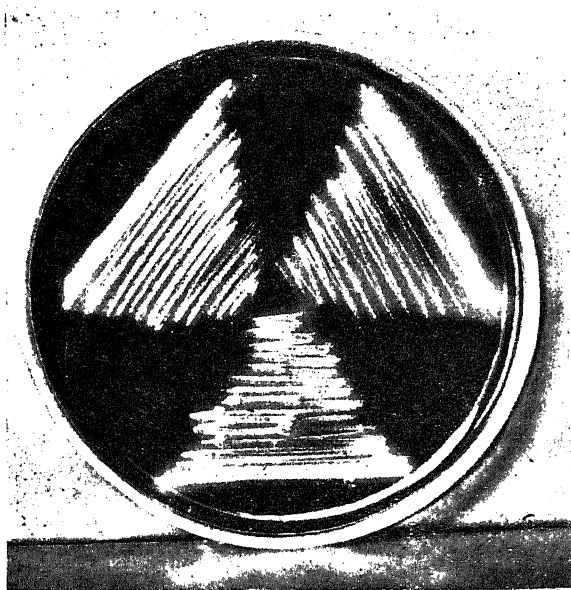
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### A SIMPLIFIED PROCEDURE FOR THE DETECTION OF HYDROLYSIS OF STARCH BY BACTERIA

DURING the course of our studies on bacteria isolated from marine sources we have had occasions to test for their starch-hydrolysing capacity. The recommended procedure<sup>1-3</sup> is to flood the starch-incorporated solid medium containing the bacterial growth with Lugol's iodine. We found that this method was beset with some drawbacks. If the plate was flooded completely with the iodine solution, the blue colour of the unhydrolysed portions was more or less masked by the brown colour of the solution. This difficulty was, to some extent,

whiffs of iodine vapour, as they struck the solid medium, produced a light blue colour which very clearly marked the zone of unhydrolysed portions.

This *modus operandi* offers a few distinct advantages. In the first place there is the saving of time and reagent. Secondly, even the slightest traces of unhydrolysed starch could be detected, thus facilitating an accurate comparison to be made of the extent of hydrolysis by different strains (*see* Figs. 1-2). Thirdly with this modified procedure there is no risk of mechanical dislocation of the bacterial growth as happens sometimes while pouring the Lugol's iodine on the culture.



FIGS. 1-2 The growths of strain No. S 63 treated by sublimation method (Fig. 1), placing drops of Lugol's iodine (Fig. 2).

overcome by placing carefully two or three drops of Lugol's iodine at widely separated places on the bacterial growth and waiting for a few minutes when the iodine, vapourising out from the solution, defined the zone of hydrolysis around the bacterial growth.

With a view to eliminate the use of iodine in the form of solution the following modification, which gave us excellent results, was effected.

The petri dish with the growth was kept in the inverted position. The bottom was lifted off, a minute crystal of solid iodine was placed at the centre of the cover and then the bottom replaced. To hasten the test, the petri dish was gently waved over the flame. The first

Our thanks are due to Dr. A. N. Bose, Director, for his interest in the work.

Central Institute of Fisheries Technology, T.D. Road, Ernakulam,  
Kerala, June 6, 1963.

K. MAHADEVA IYER.  
T. C. KARTHIAYANI.

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# OCCURRENCE OF GROWTH ZONES ON THE OPERCULAR BONES OF THE FRESHWATER MURREL, *OPHICEPHALUS PUNCTATUS* BLOCH.

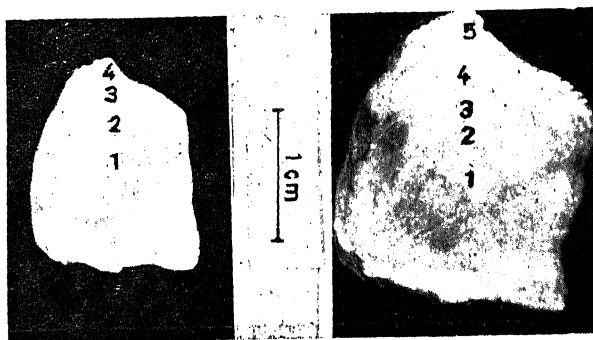
In recent years considerable use has been made of scales, otoliths and other skeletal structures by Indian workers to determine the age of tropical fishes. The recognition of marks, zones or annulations, as they are called, on various skeletal elements is the essential feature underlying the various techniques of age determination employed. Scales have been found valid for many species<sup>1-4</sup> while otoliths<sup>5-8</sup> and pectoral spines<sup>9-10</sup> have proved applicable to others. However, without going into the details of the reliability of various methods used, it is clear from the literature that even in tropical fishes definite annulations corresponding to past growth of fish do occur on skeletal parts.

Earlier studies on age and growth of Indian fishes are largely confined to marine and estuarine species. In freshwater fishes barring the scale studies on *Cirrhina mrigala*,<sup>11-12</sup> there is no other fish in which a reliable index of age has been found out. It is therefore hoped that the following account on the common freshwater murrel, *Ophicephalus punctatus* which provides for the first time the use of opercular bones as an indicator of age in a tropical fish will be of some general interest. The value of opercular bones as reliable structures of age reading has already been demonstrated in the European perch.<sup>13</sup>

Fishes collected from ponds of Aligarh were measured, sexed and their opercular bones removed by putting their head region in boiling water for about two minutes and pulling out the operculars by forceps. All opercular bones thus collected were cleaned by dipping them in a trough of water and rubbing them with fingers. In all, 619 fishes were examined. Of which 293 were males and 326 were females. Well-dried operculars were placed against a dark background and examined by the naked eye. Usually for examination no magnification was found necessary excepting in small fishes where viewing the bones under a hand-lens was sometimes helpful. Out of the total number examined, about 8% opercular bones were found unreadable.

On examination the opercular bones showed clear alternating broad and narrow zones (Fig. 1). The number of zones depended upon the size of the fish. In fishes measuring about 11-12 cm. in length, the opercular bone showed only one narrow zone at or near the outer

margin. Fishes smaller than that were devoid of any narrow zones. In large fishes the number of zones went on increasing until in very large specimens 5-6 zones were clearly seen (Fig. 1).



A

B

FIG. 1. Opercular bones of *Ophicephalus punctatus* photographed against a dark background. A. Four-year-old female, 18.5 cm. in length; B. Five-year-old male, 24.4 cm. in length.

Age of the fish was determined quite independently of its size by counting the number of narrow zones on the operculars. The conventions used for placing each fish in a particular age-group were the same as employed for the otolith readings in *Bleinnius pholis* L.<sup>14</sup> and *Centronotus gunnellus* (L).<sup>15</sup>

To establish that the zones are annual in nature the corroborative evidence or reliability test applied in the present investigation is an agreement with Patersen's length-frequency distribution in each sex. Figure 2 gives age and length distribution in each sex. Top histograms show the length-frequencies in the total sample of each sex. In the other six histograms are shown the length distributions of fish placed in various age-groups according to the opercular readings. It can be seen from the figure that the entire length-frequency curve of each sex can be dissected out on the basis of age reading. The first two modes of the length-frequency histograms clearly correspond to 0 and I + age-classes. The older age-groups are not represented in the form of successive modes and therefore these are impossible to distinguish from the size-frequency histograms. The opercular readings indicate the cause of 'non-normality' in the distribution of older age-groups. A close examination of the histograms 0-VI would reveal that for every age-group there is a considerable degree of size overlap. Such an overlap is always to be expected when the size range in any age-group is large as

compared to its annual increase in length. As the fish grows older the growth rate decreases progressively and individual variations cause a great deal of size overlap between various year-classes. Another factor which may lead to overlapping of age-groups is the prolonged breeding season of this species. It lasts from June to October.<sup>16,17</sup> The difference between the young fishes hatched during the early part of the breeding season and those hatched towards the end will be of at least three months. This difference may give rise to a size variation of several centimeters in the same year's brood and after two years a fish hatched during the early part of the breeding season may grow as large as a three-year-old fish hatched late in the season.

shows that the zones are annual in nature and can be used as growth-checks.

Such a reliable index of age in a pond-fish like *O. punctatus* which is easy to keep in captivity under all weather conditions would be of immense help to an investigator desirous to work on a hitherto unsolved problem of causative factors leading to the formation of zones on skeletal elements of tropical fishes.

Central Institute of Fisheries S. Z. QASIM.  
Education, Bombay-1.

and  
Department of Zoology, V. S. BHATT.  
Aligarh Muslim University,  
Aligarh (U.P.), July 3, 1963.

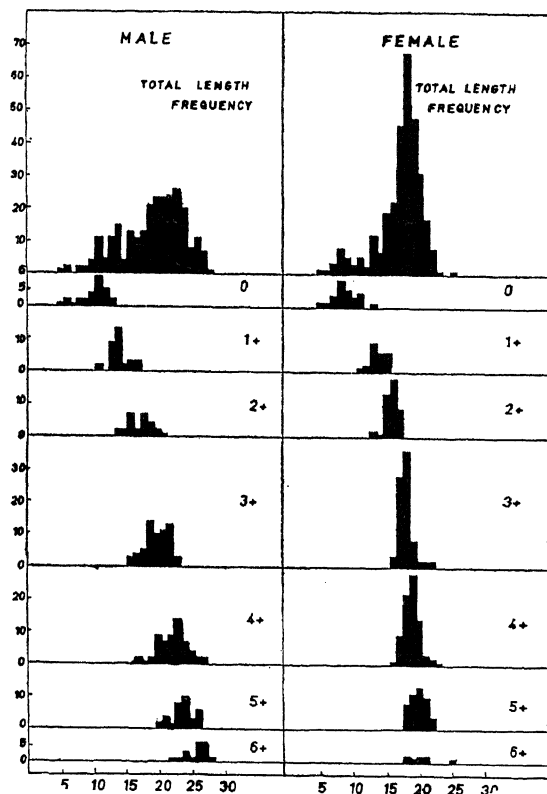


FIG. 2. Dissection of polymodal length-frequency histograms of each sex of *Ophicephalus punctatus* on the basis of opercular readings. Top histograms show the total length-frequencies. In the other six histograms are shown the various age-groups.

The good agreement, however, between the opercular readings of younger age-groups and the modes in the length-frequency distribution followed by an overlap in the older age-groups as evidenced by the opercular reading clearly

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#### NOTE ON THE NEUROSECRETORY CELLS IN THE NERVOUS SYSTEM OF THE MUSSEL, *MODIOLUS* *DEMISSUS* (MOLLUSCA: LAMELLI- BRANCHIATA)

Our knowledge of the cytology, distribution and the role of neurosecretory cells in neuroendocrine regulation in both invertebrates and vertebrates has advanced rapidly in recent years.<sup>1-3</sup> Among the molluscs, the presence of neurosecretory cells was first reported by Scharrer<sup>4</sup> in the opisthobranch, *Aplysia*. Lever<sup>5</sup> distinguished five cell types in the pulmonate, *Ferrissia*. Gabe<sup>6</sup> was the first investigator to report the occurrence of secretory neurons in 20 species of lamellibranchs. Later, Fahrman<sup>7</sup> described two types of neurosecretion in the freshwater mussel, *Unio* and Nagabhushanam<sup>8-10</sup> observed similar neurosecretory cells in *Crassostrea*, *Spisula* and *Bankia*. In this note are

presented the location and description of the neurosecretory cells in the central nervous system of the mussel, *Modiolus demissus*, with a view to extend our knowledge on the phenomenon of neurosecretion in the lamellibranchs.

*Modiolus* were collected in the vicinity of the Marine Biological Laboratory, Woods Hole, U.S.A. They ranged in shell length from 25 to 40 mm. As soon as the specimens were brought to the laboratory the shells were opened and the soft parts were fixed *in toto* in Helly's fluid. The cerebral, pedal and visceral ganglia were then dissected out, dehydrated in alcohol, cleared in xylol and embedded in Tissuemat (melting point: 56-58°C.). Serial sections were cut at 8  $\mu$  in thickness and stained with chromalum-hematoxylin-phloxin<sup>11</sup> and Mallory's triple stain.

A detailed microscopic study of the various ganglia revealed the presence of only one neurosecretory cell type. The secretory neurons are distributed along the dorsal surfaces of the cerebral, pedal and visceral ganglia. The cell bodies are pyriform in shape and measure about 20  $\mu$  in length and from 8 to 10  $\mu$  in width (Fig. 1). The nucleus is spherical and contains one to three large nucleoli. Secretory material is in the form of fine granules that stained red with Mallory's stain and blue-black with Gomori's chromalum-hematoxylin stain. In certain neurosecretory cells, the secretory material was observed in the axons. Small granules are also found within the neuropiles of various ganglia.

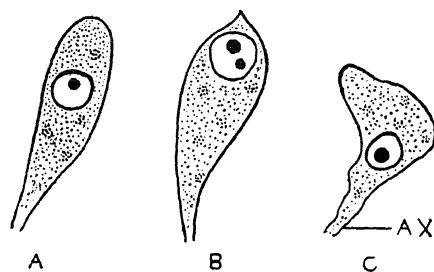


FIG. 1. Neurosecretory cells in various ganglia of *Modiolus*. Letters indicate variations in the shape of the cells. AX = Axon.

The neurosecretory cells of *Modiolus* very closely resemble the pyriform-shaped cells of *Mytilus*<sup>12</sup> and *Teredo*<sup>13</sup> and to the cell Type I of *Crassostrea*, *Spisula* and *Bankia*.<sup>8-10</sup>

The author is indebted to Dr. M. Fingerman, Professor of Zoology, Tulane University, U.S.A.,

for providing facilities for the work and for valuable suggestions; thanks are also due to Prof. P. N. Ganapati for kindly going through the manuscript and for his interest.

Zoology Department, R. NAGABHUSHANAM.  
Andhra University,  
Waltair, August 13, 1963.

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#### EFFECT OF AN EXOTOXIN FROM *PSEUDOMONAS AERUGINOSA*, S. ON TISSUE CULTURE FROM *GALLERIA* *MELLONELLA* L. IN VITRO

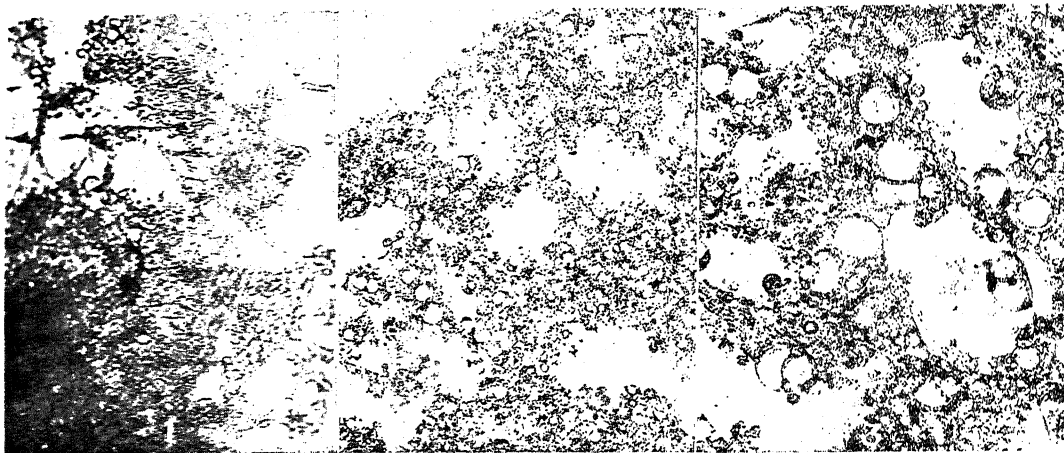
CONSIDERABLE information is available in the literature on the effect of bacterial toxins and toxoids on the vertebrate tissue cultures,<sup>1-4</sup> but no attempt seems to have been made so far to study the effect of these antigens on the invertebrate tissues. Lysenko,<sup>5</sup> however, has recently found that the long-known pathogenicity of *Pseudomonas aeruginosa*, S. to various insect species<sup>6</sup> was due to the production of an exotoxin. As an extension of his studies an attempt was made to observe the effect of the exotoxin at the cellular level in tissue cultures from *Galleria mellonella* L. *in vitro*.

In order to obtain the exotoxin the bacterium was at first grown in a tryptone broth medium (pH 7.0) consisting of casaminoacids, 1.0%; bacto tryptone, 0.5%; and mixed salts of Winter, 0.1%, for 24 hours. Bacterial cells were isolated out by centrifugation at 10,000 r.p.m. for 15 minutes. Subsequently the supernatant fluid was filtered through Seitz filter. The approximate titre of the parent stock was 9,000 LD<sub>50</sub>/ml. for *G. mellonella* larvae. Two dilutions of the parent stock at 10 LD<sub>50</sub>/ml. and 100 LD<sub>50</sub>/ml. for *G. mellonella* larvae were used in the cultures of intestinal

tissue of *G. mellonella* larvæ. The medium used was modified Trager's D<sub>4</sub>. The toxin was added 48 hours after the setting of the cultures when the cells from the culture had started proliferation. Five replications were kept for each set.

The toxin appeared to be a cytotoxin. The first symptoms, viz., granulation and the vacuolation of the cells started by the third day

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FIGS. 1-3. Pieces of intestinal tissue after 2 weeks of cultivation *in vitro*. Fig. 1. In modified Trager's medium D<sub>4</sub> showing the fibroblastic type of growth (*in vitro*,  $\times 80$ ). Figs. 2-3. In modified Trager's medium D<sub>4</sub> + toxin from *P. aeruginosa* at 100 LD<sub>50</sub>/ml. showing the granulation and the vacuolation of the cells (*in vitro*. Fig. 2,  $\times 80$ ; Fig. 3,  $\times 290$ ).

following the administration of toxin. With the passage of time the pathogenicity became more and more evident. Following granulation and vacuolation, there was a swelling of the cells. Ultimately they brought forth cell pyknosis and cell degeneration. The toxic action was irreversible as the replacement of the medium by fresh medium did not improve the condition of the cells. The effect was evident at both the concentrations, though at 100 LD<sub>50</sub> the action was very characteristic (Figs. 1-3).

Thanks are due to my colleague Dr. Oleg Lysenko of the Institute of Biology, Czechoslovak Academy of Sciences, Prague, for supplying me the toxin and to Dr. S. Krishnaswami, Director of Research, Central Sericultural Research Station, Berhampore, for valuable suggestions in the preparation of this paper.

Institute of Biology, K. SEN GUPTA.\*  
Czechoslovak Acad. Sci.  
Prague, May 16, 1963.

\* Present address: Section of Pathology, Central Sericultural Research Station, Berhampore (West Bengal), India.

#### CHROMOSOME NUMBER IN *DIGERA ARVENSIS* FORSK.

DURING a course of cytological studies of different members of the family Amaranthaceæ, undertaken by the author, the chromosome number in *Digera arvensis* Forsk. was found to be  $n = 9$ . The previous reports<sup>2,4</sup> tell us that it should be  $n = 6$ . Grant<sup>3</sup> appears to be inclined to think of an evolutionary trend in the Amaranthaceæ favouring an increase in a primary base number; the idea probably being derived from the earlier count of  $n = 6$  in *D. arvensis* the only other member, apart from the genus *Amaranthus*, with known chromosome number in the subtribe Amarantoideæ-Amarantæ-Amarantinae of the family. Looking into the similar situation in their closest allies, the Chenopodiaceæ, a constant base number of 9 (except in *Spinacia* and *Camphorosma*), is found throughout and for very simple reasons one would expect a parallel case here as well. This new chromosome number ( $n = 9$ ) in *D. arvensis* does explain the course of evolution in terms of numerical relationship of chromosomes in

different taxa more satisfactorily (Table I) and is also in consistency with the status of the species which has been supposed to be primitive on anatomical grounds.<sup>1</sup>

TABLE I

Chenopodiaceæ	Amaranthaceæ
All genera (except <i>Spinacia</i> and <i>Camphorosma</i> ) $n=9$	<i>Cleistanthus</i> , $n=9$ , $9x$ . <i>Digera</i> , $n=9$ ; <i>Amaranthus</i> , $n=(9+9)-1$ , $(9+9)-2$ ? ; <i>Aerva</i> *, $9-1$ , $(9+9)-1$ ; <i>Achyranthes</i> , $n=(9+9)+1$ , $(9+9)+3$ ? ; <i>Gomphrena</i> , $n=9$ , $9+1$ ; <i>Iresine</i> , $n=(9+9)-1$ ; <i>Alternanthera</i> *, $n=9$ , $9+1$ ? .....
Ancestral stock, $n=9$	

Chromosome numbers of the genera marked \* have been taken from author's (unpublished) own counts. Rest based on Grant.<sup>3</sup> ? might represent what the author thinks to be other monotypic and primitive genera on a par with *Digera*. Dotted line in the lowermost column indicates some of the monotypic ones without any close relations at all.

The present study is based on an intensively carried out meiotic investigation of the pollen mother cells of plants of the species collected in wild from three localities in Bihar: (i) Shyampur ( $26^{\circ}47'N$ . and  $84^{\circ}75'E$ .), a village not far from the River Gandak in the district of Champaran; (ii) Motihari ( $26^{\circ}6'N$ . and  $85^{\circ}E$ .), the headquarters of the district; and (iii) Patna ( $25^{\circ}55'N$ . and  $85^{\circ}25'E$ .). In all cases, the number of bivalents observed at late diakinesis and M I stages in the dividing cells in acetocarmine squash preparations was always nine (Fig. 1). Sometimes, however, a very close approximation of two or more bivalents together (Fig. 2) misleads to an

erroneous conclusion. This may also happen due to some sort of non-synchronization of meiotic events in the same cell showing different bivalents (or chromosomes) at different stages. Nevertheless, after the anaphasic separation, one could easily count nine chromosomes at each pole.

It has been thought desirable to publish this short note at this stage only to bring to the notice of all interested in the family the need of more and more cytological investigation especially into such monotypic and important genera like *Digera*. Is this genus a blind end in itself, with no potentiality of further evolution? Perhaps, so. And nearly one-third of the genera in the Amaranthaceæ are monotypic and sometimes have a very limited geographical distribution. How do these stand in relation to the genera which are now widely distributed and have enormous genetic plasticity? No wonder, these may come out to be very near the ancestral stock originating side by side with the Chenopodiaceæ, which retained the original base number of nine, whereas the amaranthaceous members specialized in having many other chromosome numbers (Table I). Finally, does *D. arvensis* possess more than one basic number? Answer to this lies in checking up counts from as many geographical regions as possible.

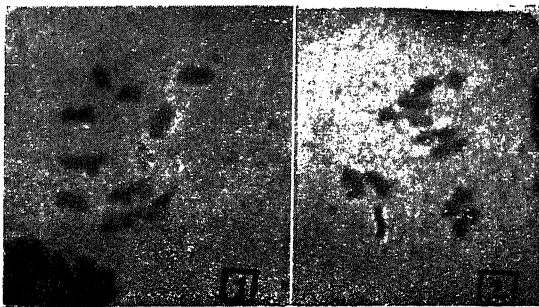
The author wishes to acknowledge with gratitude the encouragement and guidance that he received from Prof. R. P. Roy during the work. Thanks are also due to Prof. D. H. Valentine of the University of Durham, U.K., for further facilities and to Mr. J. P. M. Brenan of the Kew Herbarium for his help in identification of the materials. The herbarium specimen of *D. arvensis* from Patna, No. VT/301, has been deposited at Kew.

Department of Botany,  
The University,  
Patna-5, May 6, 1963.

V. THAKUR.\*

\* Department of Botany, University of Durham, South Road, Durham City.

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FIGS. 1-2. Photomicrographs of dividing pollen mother cells at metaphase I ( $\times 1,200$ ).

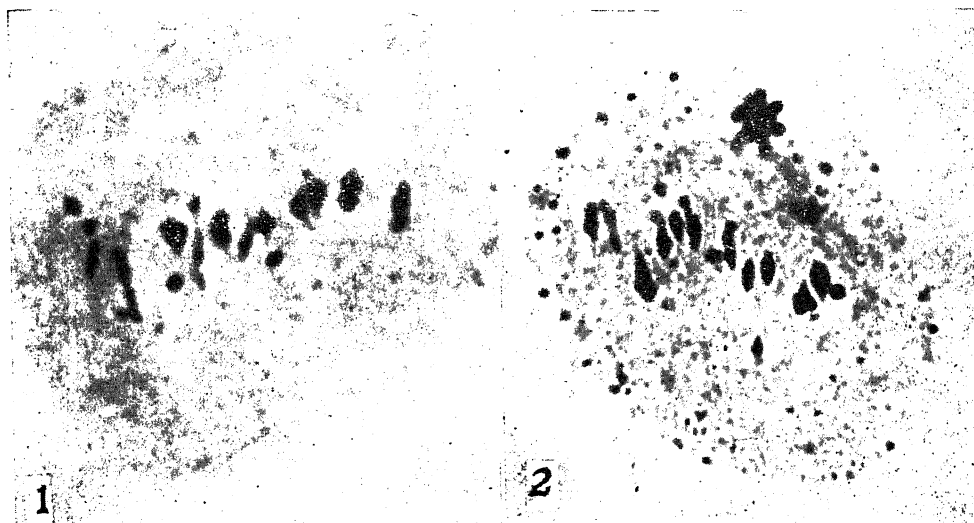
### SEEDLESSNESS IN GUAVA (*PSIDIUM GUAJAVA* L.)

SEEDLESSNESS in guava as suggested by Kumar and Ranade<sup>1</sup> is due to autotriploidy. Recently, Seth<sup>2</sup> reported that the Saharanpur seedless guava is diploid. He has mentioned that seedlessness is partially due to abnormal meiosis. Although the chromosome number of seedless type is stated to be 22, it has been shown in his Camera Lucida drawings as 23 chromosomes in almost all the plates including meiotic one. It was thought that this extra chromosome might be responsible for the abnormal meiosis in the Saharanpur seedless type. The present investigation was, therefore, undertaken to find out the cytological behaviour of the seedless type available at this Institute.

In the present study, the flower-buds were fixed in carnoy fluid (6:1:3) to which a few drops of saturated ferric chloride solution had been added. Acetocarmin was used for making PMC squash. The root-tips were fixed in 1:3 acetic alcohol from air-layered shoot and stained in leuco-basic fuchsin. Cytological studies revealed that the chromosome number was 33 in both PMC (Fig. 1) and root-tip cell.

The present findings led us to undertake the cytological investigation of the Saharanpur seedless type described by Seth.<sup>2</sup> The flower-buds and root-tips were fixed as usual, and the cytological preparations were made in the same manner stated earlier. It was observed that in this variety too the chromosome number was 33 in both PMC (Fig. 2) as well as in the somatic tissue. The meiotic configurations were almost similar to that of the seedless guava at this Institute. The number of trivalents per cell was between 7 and 11. The frequency of PMC with 11 trivalents was also very high. It is evident from these studies that the cytological behaviour of the Saharanpur seedless guava is similar to the Poona seedless type described by Kumar and Ranade.<sup>1</sup>

It is possible that Seth<sup>2</sup> might have considered the trivalent configurations as bivalents. As in Met. I, 11 bodies comprising of all trivalents are not uncommon, it is likely that the trivalent configuration have been taken as the bivalent one. This is quite apparent from the configurations of chromosomes shown in his Camera Lucida drawings of Met. I. Some of these appear to be trivalent.



FIGS. 1-2. Fig. 1. Metaphase plate showing 33 chromosomes (6 III + 5 I + 5 I) of seedless guava grown at the Institute. Fig. 2. Metaphase plate showing 33 chromosomes (7 III + 4 II + 4 I) of seedless guava grown at Sharanpur.

Meiosis was highly abnormal. The number of trivalents per cell was between 4 and 11. The frequency of PMC with 11 trivalents was also very high. The present investigation, thus, reveals that the cytological behaviour of the seedless guava at this Institute is the same as has been observed by Kumar and Ranade.<sup>1</sup>

In conclusion, it may be stated that all the three types of guava are auto-triploid. It may be possible that the source of collections of all the three types is the same.

Division of Horticulture, P. K. MAJUMDER.  
Indian Agricultural Research R. N. SINGH.

Institute, New Delhi, June 15, 1963.

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# ISARIOPSIS INDICA SP. NOV. FROM INDIA

GROVES of *Zizyphus rotundifolia* Lamk. and *Z. jujuba* Lamk. growing in the vicinity of Poona were found severely infected with follicular sooty tuft-like circular infection spots closely resembling the characteristic sooty mould caused by *Cladosporium* sp. Critical examination revealed the fungus to be a species of *Isariopsis* Fries with synnemata-like fruiting bodies and solitary conidia.

*Isariopsis griseola* Sacc.—the type species was collected on *Phaseolus vulgaris* L. from Argentina. No species of this genus has been so far reported on species of *Zizyphus*. The type species was recently collected by Srinivasan (1953) from the Nilgiris on *Phaseolus vulgaris* L. and represents the only record for India. The collection of this rare fungus at low altitudes on hitherto unreported hosts was thus significant.

A detailed comparison of the two Poona collections with the type species showed that while the two Poona collections were closely similar among themselves, they were significantly distinct in morphology as well as dimensions, from the type species (vide Table I). The

TABLE I

Species	Synnemata	Conidia	Authority
<i>Isariopsis griseola</i> Sacc.	200×30–40 $\mu$	50–60×7–8 $\mu$ 1–3-septate	Sacc., 4, 1886
<i>Isariopsis</i> sp. on <i>Zizyphus</i>	153–170.5×41–82 $\mu$	27.5–46.8×6.8–9.6 $\mu$ 1–3-septate	
<i>rotundifolia</i> and <i>Zizyphus jujuba</i>			

fungus is, therefore, presented here as a new species of *Isariopsis* with Latin diagnosis:

*Isariopsis indica* GOPINATHAN NAIR, K. R., SP. NOV.

Infectionis maculae hypogaeae. Dispersae vel, gregariae, circulares, 1–5 mm. Fructificationes in fasciculis, hypophyllae, fuliginosae; synnemata fusce olivacea laxae disposita, paulum divergentia, 153–170.5×41–82  $\mu$ . Conidiophori recti, simplices, raro ramosi, 2–3 septati, alte olivacei ad basin; pallidius ad apicem, supportantes conidia singula terminaliter et lateraliter. Conidia alte olivacea, anguste pyriformia vel fusoides, saepe curvata, 1–3 septata, efformata singula, apicalia vel lateraliter, 27.5–46.8×6.8–9.6  $\mu$ .

Maculae fuliginosae producit in foliis viventibus *Zizyphi rotundifoliae* Lamk. et *Zizyphi*

*jujubae* Lamk. Leg. Gopinathan Nair, K. R., Poona in India, December, 1962, M.A.C.S. No. 155 (type).

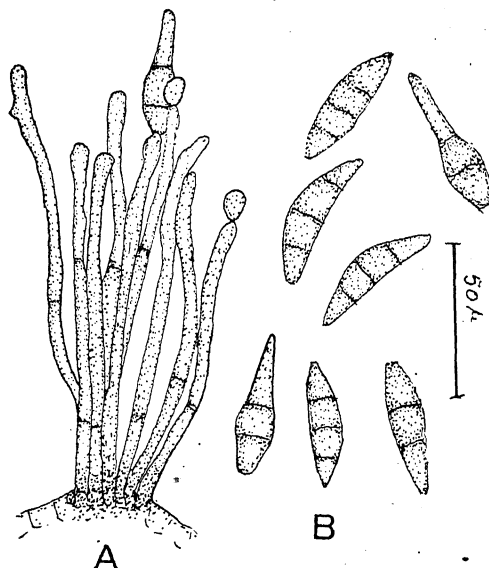


FIG. 1. A. Synnematum. B. Conidia.

Type specimens are being deposited at the Herb. Orientalis, New Delhi, India, and Commonwealth Mycological Institute, Kew, England.

Grateful thanks are offered to Prof. M. N. Kamat for his guidance and to Prof. Rev. Father H. Santapau for Latin diagnosis.

M.A.C.S. Lab., K. R. GOPINATHAN NAIR.  
Poona-4, February 16, 1963.

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## THE OCCURRENCE OF LEPTODISCUS TERRESTRIS GERDEMANN IN THE TEA GARDENS OF ASSAM

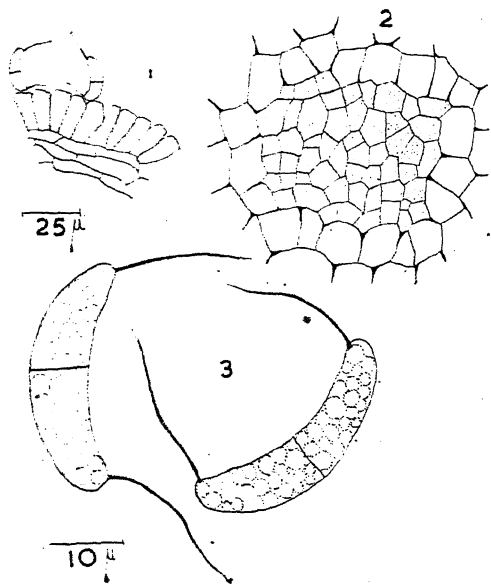
VERY often, in the field on dead seedlings of *Cajanus cajan* and *Centrosema pubescens*, a Melanconiaceous parasite was observed in tea estates around Tocklai Experimental Station. The fungus was identified as *Leptodiscus terrestris* Gerdemann.

The fungus was first described ten years ago as a new genus from United States of America<sup>1</sup> causing damping off and root rot of various Leguminosae.

The present account, as far as the author is aware, is perhaps the first report on the occurrence of *Leptodiscus* from the old world,

The following is a brief description of the fungus from a composite local collection:—

The fungus appears as a yellowish-green growth on the surface of incubated roots and the imperfect form is produced abundantly in the field as well as under laboratory conditions. The sclerotia which are deep fuscous brown and fusiform are produced rather tardily in the field.



FIGS. 1-3. *Leptodiscus terrestris* Gerdemann. Fig. 1. Spores borne on the surface of the stroma. Fig. 2. Showing the plate-like stroma. Fig. 3. Conidiophores.

The fruit body is entirely superficial, olive green or deep citron yellow to dilute brown in colour, developing as a thin plate-like structure somewhat reminiscent of the peltate scutellum of the Microthyriaceæ. The plates are rather irregular in outline and measure up to 1 mm. in diameter. Conidiophores are obsolete, conidia are produced on the upper surface of the stromatic cells. The conidial mass is pale yellowish-brown in colour and is somewhat gelatinous. The conidial wall is hyaline, smooth, the contents are granular, pale yellow, when mature turn dilute brown. Conidia are 2-celled when old, allantoid, with a thin filamentous seta at either end. The conidia measure  $30-34$  ( $-36$ )  $\times$   $4-6$  ( $-7$ )  $\mu$  and the setæ  $8-20$   $\mu$  long.

The fungus was found pathogenic to seedlings of *Cajanus cajan* and *Centrosema pubescens* which are grown as green crop and cover crop respectively in tea estates of Assam.

I am grateful to the Indian Tea Association for permission to publish this note.

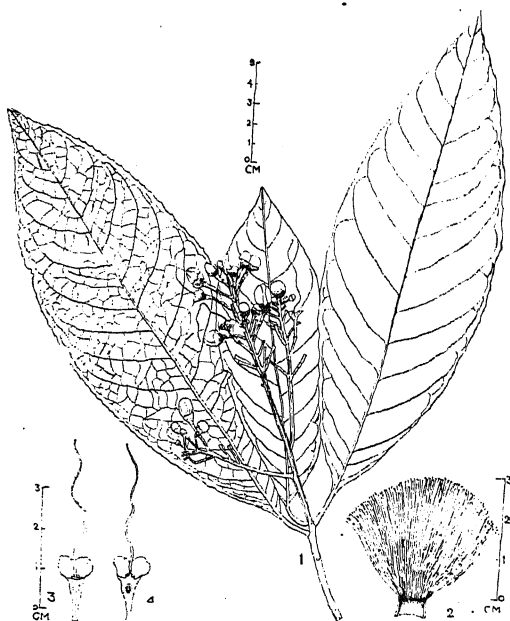
Tocklai Experimental Station, V. AGNIHOTHRUDU.  
Scientific Department of the  
Indian Tea Association,  
Cinnamara, Assam, September 23, 1963.

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#### A NOTE ON *CHYDENANTHUS EXCELSUS* (BL.) MIERS FROM THE NICOBAR ISLANDS

*Chydenanthus excelsus* (Bl.) Miers. was first described by Blume under the name *Barringtonia excelsa*. It is native in Java, a tree with broadly spreading branches and long-pointed leaves. The plant has recently been collected from one of the Nicobar Islands (Car Nicobar), which is a new record. Further, the plant does not occur in the Indian subcontinent. A short description of this plant, together with an illustration, presented in this paper will thus enrich our knowledge on the flora of the Nicobar Islands.

*Chydenanthus excelsus* (Bl.) Miers in *Trans. Linn. Soc.*, Ser. II, 1, 112, 1875; *Barringtonia*



FIGS. 1-4. *Chydenanthus excelsus* (Bl.) Miers. Fig. 1. A branch with flowers. Fig. 2. Staminal column split open. Fig. 3. Gynoecium with the disc, ovary, style and stigma. Fig. 4. V.S. of Gynoecium showing 2 erect, basal ovules, one in each cell.



*excelsa* Bl. Bijdr., Fl. Ned. Ind., 1097, 1827; *Stravadium excelsum* Bl. in DC. Prodr., 3, 289, 1828.

A tree, 8 m. high with drooping branches. Leaves simple, alternate, petiolate, exstipulate, ovate oblong to oblong, 14-27 cm. long, 5-9.7 cm. wide, glabrous, coriaceous, faintly crenulate, cuneate at base, acute to acuminate at apex; petiole 1-2.4 cm. long; lateral nerves 10-13 pairs, prominent on the abaxial side, ascending and later marginally united. Inflorescence a panicle, 10-16.5 cm. long; rachis puberulous, especially on younger parts, produced into a number of short branches at short intervals, each having articulated upon it one, ebracteate flower. Flowers pinkish-white. Calyx tube 3-5 mm. high, 5-7 mm. wide, puberulous 4-lobed, margin of the lobes fimbriate. Petals 4, obovate, 2 larger completely overlapping the 2 smaller, 1.8 cm. high, 1 cm. wide, attached by their claws to the stamiferous tube; disc cupular. Stamens numerous, monadelphous, all united below to form a tubular column, filaments slender, anthers small, all stamens fertile, a few on the innermost row reduced to hairy staminodes. Ovary inferior, 2-celled; style very long; stigma minute; ovule 1 at each cell, erect, basal.

Tiltop near Sawai, Car Nicobar Island, 26-3-1959—*Thothathri* 9330 (CAL).

Distribution Java and Sumatra.

In Calcutta Herbarium there is one sheet from Andamans, lying unidentified for a long time. It is that of David Prain, who made the following remark on the cover, '*Barringtonia* or *Planchonia*'. This particular sheet has recently been named *Chydenanthus excelsus* (Bl.) Miers. by K. Kuswata of Herb. Bogoriense. There are only one fruit and a few flowers on this sheet and no exact locality was given.

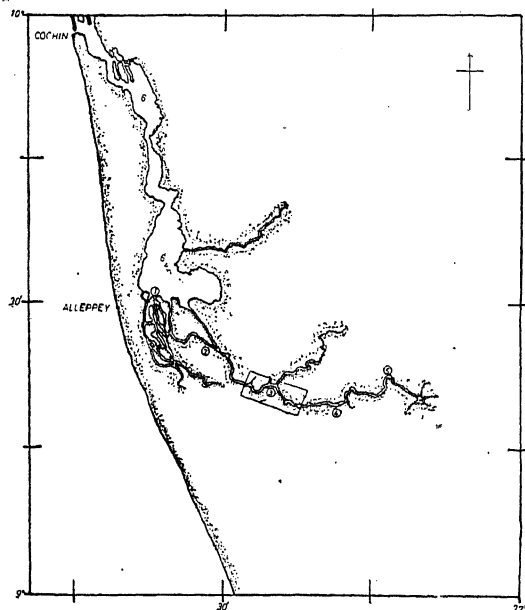
Central National Herbarium, K. THOTHATHRI.  
P.O. Botanic Garden,  
Howrah, May, 1963.

# ON THE LOCATION OF A NURSERY GROUND OF THE GIANT PRAWN *MACROBRACHIUM ROSENBERGII* (de MAN)\*

IN the course of an investigation extending over the past four years on the biology and fishery of *M. rosenbergii* in the Vembanad Lake and Pamba River in Kerala State, some interesting observations have been made in regard to the distribution of the juvenile prawns,

The species supports a rich fishery in the backwaters and rivers of Central Kerala, the importance of which has risen steadily in recent years with the increase in demand for frozen shrimps in foreign markets. The fishing season extends from May to November. Spent specimens and early larval stages are available only in the backwaters during August to December, thus indicating clearly the place and time of breeding. This observation relating to the distribution of the early larvæ is in agreement with those of Menon (1938) and John (1957). From breeding experiments conducted in Malaya, Ling and Merican (1961) are inclined to believe that survival of the larvæ requires a certain amount of sea-water and that they "under natural conditions live in brackish-water".

In order to trace the distribution of the species, especially of young ones in the Pampa river, five stations about 10 miles apart were fixed along its course for regular observations during the off-season from January to May (Ref.: map). Juveniles of the species measur-



Map showing the Vembanad Lake and Pamba River with the observation stations. (1) Pallathur thu; (2) Raman-kari; (3) Pulikizh; (4) Ayanmula; (5) Ranni; (6) Vembanad Lake. Nursery area in the river shown enclosed within rectangle.

ing 30-160 mm. were first recorded in January 1961, in the catches of a type of drag net locally called *Peru vala* landed at about 3 miles east of Pulikizh (the third observation station).

This place is a regular landing centre of riverine fishes among which juveniles of *M. rosenbergii* are found along with those of *M. rudis*, *M. idæ* and *M. malcolmsoni* during the period, January to May. The catches come from a stretch of the river about 10 miles long, extending equally on both sides of Pulikizh.

The peculiarity of this area is that the river at this point is rather deep in places (even up to 12 metres). These deeper parts are known in the locality as *kayam*. The Manimala stream, a tributary of Pamba, joins it near this point. The water is fresh throughout, the saline influence becoming evident only lower down at Ramankari and Pallathuruthu. The bottom of the *kayam* is generally of loose mud with plenty of organic detritus, unlike the shallow regions of the river which are sandy at the bottom.

Juveniles of *M. rosenbergii* can easily be distinguished from those of the other species by the presence of parallel longitudinal lines on the carapace. In others such lines are either absent or when present are transverse in disposition.

It is possible that other areas in the river systems associated with the Vembanad lake with similar ecological conditions might also prove to be valuable nursery grounds of the species. During certain years it has been observed that these juveniles move down the river from March onwards probably under the influence of currents resulting from occasional showers. It is suggested therefore that the best time for collection of juveniles for purposes of culture is January and February when the percentage of juveniles below 100 mm. is also high (Table I). The author has observed during the course of this work that the juveniles have a habit of hiding in crevices or among submerged plants along the river banks. This observation can be of practical use in their collection for stocking and culture.

I am deeply indebted to Dr. S. Jones, Director, for his keen interest and encouragement and to Shri M. Krishna Menon for guidance. I am grateful to Sarvashri P. C. George and M. J. George for valuable suggestions and helpful criticism.

TABLE I

Month	Size range (mm.)		Modal size-groups (mm.)		Sex ratio %		Juveniles up to 100 mm. %
	♂	♀	♂	♀	♂	♀	
January ..	58-234	30-87	61-80, 141-160 and 221-240	61-80 and 141-160	51.7	48.3	55.2
February ..	61-260	34-164	61-80, 181-200 and 221-240	41-60	46.4	53.6	67.5
March ..	60-238	51-148	61-80, 141-160 and 221-240	81-100 and 141-160	62.1	37.9	54.7
April ..	68-217	56-133	101-120 and 161-180	81-100 and 101-120	56.7	43.3	39.2
May ..	61-260	61-170	101-120 and 161-180	81-100 and 101-120	67.1	32.9	30.3

The data pertaining to the samples of *M. rosenbergii* from this centre for the five months, January to May 1961, are presented in Table I.

It can be seen from Table I that along with the juvenile prawns a small proportion of large males are also encountered. But large females are conspicuous by their absence. The occurrence of these juveniles in large numbers in this area during the same period has been confirmed in 1962 and 1963.

They are found to feed actively on a variety of animal and vegetable matter from among the bottom debris. It was also interesting to note fish remains in the stomachs.

Central Marine Fisheries  
Research Institute,  
Ernakulam, May 30, 1963.

K. RAMAN.

\* Published with the kind permission of the Director C.M.F.R. Institute, Mandapam Camp.

1. John, Mary C., "Bionomics and life-history of *Macrobrachium rosenbergii* (de Man)." *Bull. Cent. Res. Inst., Trivandrum*, 1957, 5 (1), 93.
2. Ling, S. W. and Merican, A. B. O., "Notes on the life and habits of the adults and larval stages of *Macrobrachium rosenbergii* (de Man)," *Proc. Indo-Pac. Fish. Comm.*, 9th Session, 1961, 2, 55.
3. Menon, M. K., "The early larval stages of two species of *Palaeomon*," *Proc. Ind. Acad. Sci.*, 1938, 8, 288.

## REVIEWS

**Advances in Physical Organic Chemistry** (Vol. I). Edited by V. Gold. (Academic Press), 1963. Pp. x + 444. Price 90 sh.

The last three decades have seen the development on a large scale of almost a new branch of chemistry and the output of papers, especially outside Britain, has been so large that it is difficult for any one outside the circle to keep pace with the publications. The volume under review fulfils a need though the limitation of such an approach are unavoidable. The first volume of this series rightly carries the foreword by Ingold who has been essentially a creator of this new branch and it is equally appropriate that the editing is in the hands of one of his pupils.

The volume contains six monographs of about the same length. Professor Long rightly emphasises the importance of entropy of activation in elucidating reaction mechanisms. While the critical approach includes a number of related reactions, the value would have been enhanced by a more extensive treatment. The longest section in the volume is the monograph of Prof. H. C. Brown whose voluminous publications in the field are well known. While there is the recognition of the importance of the thermodynamic quantities, the mass of data analysed in the monograph rests on a discussion of the composite quantity, rate constant and the related Hammett parameters including the modifications thereof. The value of the contribution is thus restricted and one has to probe further. The third monograph on hydrogen isotope exchange in liquid ammonia is of value in providing material which is readily available only to those conversant with the Russian language. The reactivity of the compounds and the effect of reagents are clearly developed and the use of the medium as a synthetic environment well brought out. Professor Robertson has provided a masterly survey of planar and non-planar aromatic systems and gives us a very useful critical account of the overcrowding and consequent spatial changes in such systems. Prof. Symons has given us a short account of the relatively new tool of ESR in the study of free radicals in solutions, crystals and glasses and has brought out also the limitations of the technique. The appendix to this monograph will be found useful by one

starting to use the technique. The last article is an interesting outline of the theory of electronic spectra and their applications to a variety of excited molecules.

The volume under review fulfils the objectives of the editor and is indispensable for any laboratory doing or contemplating work in the field. The volume will be found useful by every post-graduate institution training students in modern organic chemistry.

S. V. ANANTAKRISHNAN.

**Methods in Carbohydrate Chemistry** (Vols. II and III) :

Vol. II: *Reactions of Carbohydrates*. Edited by R. L. Whistler and M. L. Wolfrom. (Academic Press, New York and London), 1963. Pp. xvi + 572. Price \$ 19.50.

Vol. III: *Cellulose*. Edited by R. L. Whistler. (Academic Press, New York and London), 1963. Pp. xvi + 408. Price \$ 15.50.

The rapid developments which have taken place in experimental techniques in the chemistry of carbohydrates in recent years has made it very difficult for research workers in this field to keep pace with them. Hence the appearance of the volumes of *Methods in Carbohydrate Chemistry* will be widely welcomed by the carbohydrate chemists all over the world. The detailed practical methods pertaining to various aspects of carbohydrate chemistry covered by these volumes can readily be repeated by the experimenter without any necessity of referring to the original literature.

These two volumes have kept up the sustained interest created by the first volume of the series published in 1962.

The second volume deals with various reactions of simple carbohydrates and is divided into 17 sections. The first seven sections are devoted to subjects of wider and of general interest such as classification of blocking groups, oxidation and reduction products, derivatives of nitrogen bases, etherification, esterification and acetalation and includes many varied examples giving detailed and most suitable preparative methods under these heads. Section 8 through 16 deal in more specialized fields such as unsaturated sugars, osones, acyclic monosaccharides, thio-sugars, the oxo-reaction, Grignard and Friedel-Crafts reactions with sugars,

saccharinic acids and isotopic carbon distribution in aldoses. The last section gives a 6-page list of references of selected methods in carbohydrate chemistry and is very useful as a ready reference to the original literature for the preparation of specific carbohydrate derivatives not covered by the book.

The third volume is devoted completely to cellulose and is divided into nine sections. The first section deals with the preparation of pure cellulose samples from different sources and that of holocellulose from annual plants. The next two sections deal with the various methods of chemical and physical analyses required in cellulose chemistry. The physical methods include the application of infra-red spectra coupled with hydrogen-deuterium exchange method for the determination of hydrogen bonding and degree of crystallinity of various types of cellulose. One of the more important aspects of cellulose chemistry, namely, the degradation of cellulose, is the subject-matter of Section 4, which deals with the methods of enzymic and acidic hydrolysis of cellulose including acetolysis and mercaptolysis, graded alkaline degradation, oxidation of cellulose with various oxidants, borohydride reduction of carbonyl groups of oxycellulose and the effect of ionizing radiation on cellulose and its derivatives.

The preparation, properties, reactions and analysis of cellulose esters are given in Section 5, the more important esters acetate, nitrate and various aspects of the xanthation process being treated in greater details. Methods for the preparation of the more important cellulose ethers such as methyl, ethyl, hydroxyethyl, carboxymethyl and cyanoethyl ethers with different degrees of substitution and methods of estimation are given in Section 6. The use of light and electron microscopy of cellulose fibres to provide additional data for the evaluation of cellulosic materials is described in Section 7. Section 8 contains only one article dealing with laboratory equipments required for carrying out reactions with cellulosic materials which often comprise of heterogeneous or viscous reaction systems. The last section of this volume deals with the preparation of  $C^{14}$ -labelled cellulose by introducing  $C^{14}$ -labelled D-glucose in the maturing cotton boll and determination of the  $C^{14}$ -label distribution in the cellulose.

A glossary at the end of each of these volumes lists the names and source of proprietary substances required for the various preparations described.

J. L. Bose.

**The Identification of Molecular Spectra** (3rd Edition). By R. W. B. Pearse and A. G. Gaydon. (Chapman and Hall Ltd., 37, Essex Street, London W.C. 2), 1963. Pp. xi + 347. Price £ 6.net.

Originally intended as an aid to practical atomic spectroscopists to identify, and so to eliminate, the troublesome bands which are frequently encountered in the photographic plates of the arc and spark spectra of elements, and which are attributable to impurities in the electrodes and in the atmospheric media, these Tables of molecular bandheads have in their utility gone beyond their original intention, and now stand in their own right as an indispensable source book of information on the spectra of simple types of molecules.

The first edition of this publication appeared in 1941 and the second edition in 1950. During these twelve years molecular spectroscopy has made rapid progress both in its scope and in its application. The increase in the size of the successive editions of this book stands as an ocular evidence of this progress. Apart from the theoretical importance of the analysis of band systems as revealing the structure of molecules and their energy levels, application of molecular spectroscopy in astrophysics and in the physics and chemistry of atmospheres (terrestrial as well as planetary) is growing in interest. A new field of study is atmospheric pollution where molecular spectroscopy is used to identify the pollutants formed by photochemical reactions in the atmosphere.

The book is in three sections. The first section of about 50 pages, gives a list of the strongest bandheads of the more persistent type, arranged in order of wavelength from 10,000 Å to 2,000 Å, together with their molecular origins and their visually estimated intensities in various sources. The second section which really forms the bulk of the book (pages 51-320), gives details of the individual bands for each system of bands produced by the molecule concerned, their electronic and vibrational assignments, appearance and intensity, and references to the sources of the data. The molecules are taken up in the alphabetical order of their chemical symbols. The data refer mostly to diatomic and triatomic molecules. In the third section some useful hints are given on practical procedure and precautions in taking molecular spectra, their identification and analyses. There are 12 full-page plates exhibiting a number of band systems which are frequently encountered and which

will be of great help to the beginner in identifying the commonly occurring bands.

The new material added to the third edition comprises: (i) data for 84 molecules which appear for the first time, (ii) for 135 molecules the observations have been extended and (iii) the Table of persistent bandheads has been revised and 350 new entries have been made.

As mentioned earlier, the Tables of Molecular Spectra is an indispensable acquisition to all spectroscopic laboratories. New laboratories should go in for this publication, and old ones should replace the older edition by the new one.

A. S. GANESAN.

#### The Quantum Theory of Many-Particle Systems.

Edited by H. L. Morrison. (Gordon and Breach, Science Publishers, New York), 1963. Pp. xiv + 345. Price \$4.95.

During the last decade, great strides have been made in the quantum mechanics of many particle systems and a vast literature has grown around topics like the nuclear structure, perturbation methods, Green's functions and superconductivity. A noteworthy feature of the recent developments is that ideas and techniques, which till now have found application in field theory alone, have been used in the many-body problem also. Several books of late have appeared on the many-body problem and of these a few are review series, containing a collection of reprints of some important papers on the subject. The volume under review is yet another addition to these reprint editions.

The volume contains twenty papers dealing broadly on statistical mechanics, diagrammatic perturbation theory, Green's functions, superconductivity, and a preface by H. L. Morrison. The first paper in the collection is a contribution by R. P. Feynman to the atomic theory of liquid helium. Starting from a variational wave function for the helium system, the author shows that the lowest portion of the energy spectrum varies directly as the magnitude of the momentum vector. The next series of papers by Brueckner, Gammel, Goldstone and Bloch deal with the development of a form of perturbation theory which is suitable for treating many-particle systems wherein interactions are strong. These papers contain in essence a derivation of the linked cluster expansion theorem for the ground state energy of a many-particle system. The linked cluster expansion is a method of rearranging and collecting terms in perturbation expansion in order to prevent the occurrence of divergencies and to assess the contribution of

all terms of given order. The development of the perturbation theory for many-body systems, following the diagrammatic method of Feynman, was carried through by Goldstone and Hugenholtz. In the hands of Brueckner, Gellman and Hubbard, this technique yielded very interesting results concerning the correlation energy of an electron gas in a metallic lattice.

It is well known that Green's functions played a dominant role in electrodynamics but recently this technique was successfully adapted to the treatment of many-particle systems also. The papers by Matsubara, Klein and Prange, Martin and Schwinger will provide the reader with a good account of Green's functions for the ground state of the system as well as Green's functions for a microcanonical ensemble which is useful in studying the thermodynamic properties of matter. The volume comes to an end with a paper by Kadanoff and Martin, which relates to the mathematical theory of superconductivity.

In a vast subject like the many-body problem, it is difficult to pick up a few papers and call them alone important, but the guiding principle of selection of a paper in the volume seems to be (apart from its importance) its recent appearance, the prevailing fashion and the flavour of field theory that the paper emanates forth. Unfortunately several of the papers in the volume also find their appearance in the two books on many-body theory edited respectively by D. Pines and L. Van Hove, and the reviewer is unable to understand why the repetition of reprint articles should be carried to this extreme limit.

K. S. VISWANATHAN.

Ultra-violet and Visible Spectroscopy—Chemical Applications. By C. N. R. Rao. (Butterworths, London), 1961. Pp. xiii + 164. Price 30 sh.

While the classification of the topics on electronic spectroscopy as presented here is good, the book has been badly written. In parts it seems that the matter has been presented for a beginner in great (and even unnecessary) detail, while there are portions which a research chemist will find it difficult to comprehend. The language and composition leave much to be desired, the sentences are short and abrupt; there is too much repetition with consequent loss of space for sections which deserve greater detail, and more material could be incorporated in the space so generously given by the publishers. The most useful pages of the book are the references.

After a treatment of the experimental procedures and basic concepts, chromophores and electronic transition, separate chapters on simple, conjugated, aromatic and heterocyclic molecules appear. These are followed by chapters on applications, steric effects, the far ultra-violet spectra of organic molecules, fluorescence and charge transfer spectra. A section on miscellaneous topics deals among others with the ligand field theory, colour centres in inorganic compounds, optical rotatory dispersion, and hydrogen bonding. There is a three-page appendix on the spectra of proteins.

B.

#### Advances in Applied Microbiology, Vol. 5.

Edited by W. W. Umbreit. (Academic Press, New York and London), 1963. Pp. xi + 385.

This volume, like the previous four, has brought within its covers several comprehensive reviews on a broad range of subjects of interest to the applied microbiologist.

The first review, entitled "Correlations between Microbiological Morphology and the Chemistry of Biocides" deals with the micro structures and biocides respectively of bacteria, fungi, viruses and protozoa. In the second review are presented details of the "Generation of electricity by microbial action". The third article is devoted to a discussion of the possibility of using the microbial "equivalents" of cancer to a better understanding of the molecular biology of this disease the etiology of which still remains to be established. In the next are presented some of the classical microbiological techniques along with those recently developed with radio-isotopes as tools for more rapid determinations, e.g., coliform test in water analysis and prospecting of petroleum and gas, etc. The next article represents an attempt made to explore the more recent interesting developments on the commercially important fermentation of 2, 3-butylene glycol and an examination of the possibilities of its future use.

The problem of aeration is an all-important one in every microbiological laboratory. This vital problem is reviewed with special reference to the methods in use for the measurement of air (oxygen) and the means available for effecting a control thereon. Likewise, every microbiologist is confronted with the problem of stability of his microbial cultures and the measures to be adapted to retain their morphological and other characters. These aspects, together with ways and means for preventing culture degeneration, have been covered in another review.

It is often not realised that micro-organisms are responsible for the disfiguring of decorative and other paint films. The microbiological problems associated with the paint films and the steps which may be taken to achieve a control are discussed in another article.

The actinomycetes and their antibiotics occupy the pre-eminent position in microbiological industries and the literature on them accumulates so rapidly that periodic review has become a matter of paramount importance. In an exhaustive review Dr. Waksman, who for decades has investigated upon these microbes and their activities, has ably covered the vast literature of the past two years on this important subject.

The last review on fusel oil, starting with the early history of this bye-product of alcoholic fermentation, describes the characteristics of its components and discusses not only the factors affecting its formation but also the biosynthesis of its components.

The book will serve as a reference manual and source book of information on all the ten topics covered.

J. V. B.

#### Books Received

*International Geophysics Series* (Vol. 5)—An *Introduction to Atmospheric Physics*. By R. G. Fleagle and J. A. Businger. (Academic Press, New York-3), 1963. Pp. xi + 346. Price \$ 12.00.

*Biochemistry of Industrial Micro-organisms*. By C. Rainbow and A. H. Rose. (Academic Press, Berkeley Square, London W. 1), 1963. Pp. xix + 708. Price 147 sh.

*Advances in Electronics and Electron Physics*. (Vol. 18). Edited by L. Marton. (Academic Press, New York-3), 1963. Pp. x + 342. Price \$ 12.50.

*Mathematics in Science and Engineering*. (Vol. 10). By J. T. Tou. (Academic Press, New York-3), 1963. Pp. xi + 186. Price \$ 7.00.

*Advances in Heterocyclic Chemistry* (Vol. 2). Edited by A. R. Katritzky. (Academic Press, New York-3), 1963. Pp. xiv + 458. Price \$ 14.00.

*Advances in Agronomy*. Edited by A. G. Norman. (Academic Press, New York-3), 1963. Pp. xi + 415. Price \$ 13.50.

*Veterinary Entomology and Acarology for India*. By S. K. Sen and T. B. Fletcher. (Indian Council of Agricultural Research, Rajendra Prasad Road, Krishi Bhavan, New Delhi), 1962. Pp. viii + 668. Price Rs. 20.00.

## SCIENCE NOTES AND NEWS

### High Resolution Study of Stimulated Raman Radiation

Prof. B. P. Stoicheff of the National Research Council, Ottawa, Canada, has reported on the results of his recent study on stimulated Raman spectra of several liquids, in particular liquid hydrogen, oxygen and nitrogen, excited by intense maser light (a giant-pulse ruby laser emitting radiation of energy 0.3 joule in single bursts of duration 20 nsec.) and observed under conditions of high resolution using a 21 ft. grating of resolving power  $10^5$ . A glance at any of these spectra shows them to have most remarkable properties when compared with the corresponding normal Raman spectra. The spectra are extremely intense, they consist of Stokes and anti-Stokes lines of almost equal intensity; the lines correspond to molecular vibrations of a particular symmetry only, each spectrum also exhibits lines of exact multiples of these frequencies; the lines of some liquids appear to be extremely sharp, but on occasion these same lines are several angstroms in breadth, sometimes exhibiting fine structure and, sometimes, unusual intensity contours; finally, the radiation exhibits a marked angular dependence which is different for Stokes and anti-Stokes frequencies.

While some of these characteristics can be understood from existing theories of "ordinary" stimulated Raman radiation, the present results show that these theories are not adequate for an understanding of the processes involved when the excitation is by intense coherent light. Thus for instance, in the normal Raman effect anti-Stokes emission corresponds to transitions from a higher to a lower level, e.g.,  $v=1 \rightarrow v=0$ . At the temperature of liquid hydrogen, and even liquid oxygen and nitrogen, vibrational levels other than  $v=0$  are not populated in these liquids and indeed no anti-Stokes radiation is found in the normal Raman spectra of liquid hydrogen, oxygen and nitrogen. Yet in the stimulated spectra anti-Stokes lines are present with appreciable intensity in them.

To understand some of the new characteristics observed Prof. Stoicheff puts forward the following classical approach:

"Consider that the intense maser radiation excites by means of the Raman effect a set of molecules vibrating coherently at the Raman frequency. The resulting variation in refractive index acts like a 'phase grating' which then

modulates and scatters the original light, thus producing sidebands or many Stokes and anti-Stokes frequencies. At the present time, however, several features of the spectra remain to be explained and may require higher-order processes or perhaps interactions of intense light and acoustic waves in the medium."

It may also be mentioned that liquid parahydrogen was included in the study especially to look for stimulated Raman radiation corresponding to molecular rotations, but none was found.—(*Physics Letters*, 15 November 1963.)

### Detection of Meteoric Fragments by Laser

Using a laser as part of an optical radar G. Fiocco and L. D. Smullin of the MIT Research Laboratory of Electronics reported observations of optical echoes from minute particles at heights of from 60 to 140 kilometres. According to them concentrations appeared in two regions—one around 80 km. and the other around 120 km. In the absence of independent methods they could not say what caused these echoes. However, it is tempting to compare the lower echoes (approximately 80 km.) with the visual heights of noctilucent clouds. And it may be speculated that the more distant echoes (approximately 120 km.) correspond to the region of meteoric break-up. It is well known that very small meteors shower into the earth's atmosphere continuously and do not burn up but instead fragment into still smaller particles that eventually settle to earth.—(*Electronics*, October 1963.)

### Ocean Floor Fault Near the Atlantic Coast

Local anomalies in the earth's magnetic field along the Atlantic coast have revealed a deeply buried fault in the earth's crust beginning at least 400 miles out in the Atlantic and extending across New Jersey to central Pennsylvania. The fault which has a length of 600 miles or more suggests considerable movement of segments of the earth's crust. The fault was uncovered by C. L. Drake and his associates of the Lamont Geological Observatory of Columbia University. During a study of magnetic data collected by Government agencies and a number of oil companies, a curious feature was noticed in records for areas around the 40th parallel. The pattern of anomalies was repeated on both sides of a line running approximately along the 40th parallel; to the north of the line, however, it was shifted 100 miles to the east. The pattern

of displacement was interpreted as evidence of a buried fracture in the ocean floor.

Writing in the *Journal of Geophysical Research*, Drake and his associates note that the fault—the first ocean-bottom fracture known to continue onto the shore—provides new evidence of sizable crustal movements. However, the newly discovered fault appears to date back some 200 million years and to have been quiescent since then. This is difficult to reconcile with other recent studies suggesting a considerable change in the position of the continents in the past 200 m. years. In addition the direction of displacement is opposite that of several fractures in the floor of the Pacific.—(*Scientific American*, November 1963.)

#### Studies on Sex-Linked Enzymes

Recent studies of a sex-linked enzyme defect indicate that one of the two X chromosomes of the human female (the male has only one) is active in some of her somatic cells and the other X chromosome is active in the rest. This finding lends credence to a hypothesis first advanced two years ago: that the sex chromatin—a distinctive body found in the nuclei of female somatic cells—is a displaced X chromosome and that in each female somatic cell only one X chromosome is fully active.

In 1961 Mary Lyon of the British Atomic Energy Establishment, and Liane B. Russell of the Oak Ridge National Laboratory independently suggested that in mammals one X chromosome is inactivated in some embryonic cells and their descendants, that the other is inactivated in the rest and that mammalian females are consequently X-chromosome mosaics. Their conclusion was based on the behaviour of coat-colour genes located on the X chromosomes of rats and mice.

In humans a comparable X chromosome gene governs the formation of glucose-6-phosphate dehydrogenase, an enzyme involved in the utilization of glucose. The gene has at least two forms; one gives rise to an "A" species of enzyme and the other to a "B" species. In addition a third form of the gene (probably a missing gene) results in a deficiency of the enzyme. The A and B genes occur in Negroes, the B gene and the gene for deficiency in Caucasians.

Studies of the production of the enzyme in skin cells taken from Negro women with genes for both A and B enzymes, and in white women with genes for the B enzyme and enzyme deficiency have in both cases revealed the existence of two distinct population of cells.

This work was reported in the *Proc. Nat. Acad. Sci.* by R. G. Davidson, H. M. Nitowsky and B. Childs of the Johns Hopkins School of Medicine.—(*Sci. Amer.*, November 1963.)

#### Plasma Temperature in Fusion Research

An electron "thermometer" capable of measuring temperatures in millions of degrees was announced recently at a meeting of the American Physical Society by scientists from the General Electric Research Laboratory. The new technique takes advantage of trace impurities, atoms of oxygen and carbon, existing in the high temperature plasma used in fusion research. The plasma consists principally of heavy hydrogen (deuterium), ionized so that it conducts electricity.

To achieve these high temperatures the plasma is compressed using a strong magnetic field in a form of "magnetic bottle". The intense electric discharge created during this process "strips" electrons from the impurity atoms of oxygen and carbon in the plasma. By measuring the visible and ultraviolet radiation emitted as the electrons are torn loose, it is possible to determine the temperature of the electrons at various stages of the experiment. Temperature measurements are made continuously throughout the few millionths of a second during which the plasma is compressed.—(*Jour. Frank. Inst.*, September 1963.)

#### Monomer-Dimer Forms of Bence Jones Proteins

Bence Jones proteins, the abnormal biosynthetic products, excreted in the urine of myeloma patients, are defined as low-molecular-weight proteins, antigenically and chemically related to  $\gamma$ -globulin, which precipitate when heated to temperatures near 50° C., dissolve on boiling, and reprecipitate on cooling. Edelman and Gaily (*J. Exp. Med.*, 1962, 116, 207) have presented evidence that L-chains obtained by reductive cleavage of 7 S myeloma globulins are closely related to, if not identical with, the Bence Jones protein from the same individual. These L-chains have molecular weight of approximately 20,000, and these authors postulate that the usual 3.5 S Bence Jones protein exists as a dimer of L-chains. In a communication to *Nature* Prof. F. W. Putnam and Dr. G. M. Bernier of the University of Florida have demonstrated the existence of polymerism in several Bence Jones proteins. The results are illustrated by a description of chemically and antigenically identical monomer and dimer forms of one such protein obtained by ammonium sulphate precipitation from the urine of a myeloma patient.—(*Nature*, 1963, 200, 223.)



# DEFECTS IN CRYSTAL LATTICES

S. BHAGAVANTAM

## 1. INTRODUCTION

A PERFECT crystal is one in which a regular arrangement of atoms extends periodically and indefinitely in space in all the three directions. It can be looked upon as a three-dimensional array of identical lattice cells within each of which the atoms are identically arranged. Such a crystal is only a concept and an idealisation and does not actually exist. However, the concept proved to be quite useful in understanding several properties of crystalline solids.

It was realised quite early that the theory of perfect crystals is not adequate to explain satisfactorily many interesting properties such as plastic deformation, ionic conductivity, diffusion, luminescence and some other mechanical, optical and electrical properties. It has been found necessary to postulate departures from perfection in the structures of crystals to explain such properties. Several kinds of imperfections or defects have thus come to be recognised and introduced from time to time. It has even been stated that the more interesting properties of crystalline solids depend on the defects in its assumed ideal structure rather than on the structure itself.

By an imperfection or a defect is meant any deviation from the perfect periodic order that should exist in an ideal crystal. The possible imperfections are usually classified as zero, one, two, and three-dimensional imperfections. If the deviations are localised and confined to the vicinity of a few atoms, they are zero-dimensional or point defects. If they extend along lines, they become one-dimensional or line defects. Two-dimensional or surface imperfections and three-dimensional or volume imperfections are conceived of and understood in a similar way. We shall be concerned with point defects only in this short survey.

## 2. POINT DEFECTS

It has been shown from considerations of entropy that even in a perfect crystal, there would exist in equilibrium a certain number of point imperfections at a given temperature. There are many kinds of point defects. The simplest one is a missing atom or a vacancy. In ionic crystals, there should be present as many vacancies of the positive ion as there are of the negative ion to ensure neutrality of the

crystal as a whole. Such vacancies are called *Schottky defects*.

Another kind of point defect appears when an atom or ion is displaced from its position into an interstitial position creating a nearby vacancy. Such a displacement occurs readily in structures which contain relatively large interatomic voids. Interstitial ions or atoms and consequent ion or atom vacancies are called *Frenkel defects*.

Presence of foreign atoms or ions either in the interstitial positions of the host structure or in the positions of the host atoms themselves by substitution are also regarded as point defects. These are called *interstitial and substitutional impurities* respectively.

It is not difficult to see that the density of a crystal may be expected to increase, remain unchanged, or decrease respectively with increasing defect concentration according as the defects are of the interstitial, Frenkel or Schottky type. Interstitials and vacancies, when present in considerable density, may interact to form clusters and give rise to interesting physical properties. Breckenridge<sup>1</sup> has pointed out that Schottky defects forming into pairs of opposite signs possess a dipole moment and should cause dielectric relaxation effects. Positive ion vacancies which are characterised by a negative charge get attached to divalent substitutional impurity ions in alkali halides and have been found to give rise to dielectric relaxation effects. In fact, various types of relaxation effects caused by point defects in crystals constitute an interesting group of physical properties and these have been the subject-matter of several recent studies.

## 3. RELAXATION PHENOMENA

It has just been pointed out that Schottky defect pairs and vacancies bound to divalent impurity ions can cause dielectric relaxation effects. One may expect that, under certain circumstances, they should cause the analogous mechanical effect as well, namely internal friction. The mechanical effect, when observed, has been explained as due to the non-equivalence of lattice points brought about by the strain in the lattice due to external stress. A special feature of the mechanical effects, as distinct from the electrical ones, is that they may be caused by uncharged point defects as well,

Calcium oxide ( $\text{CaO}$ ) goes into solid solution in thorium oxide ( $\text{ThO}_2$ ). The latter crystallises in the cubic system having the fluorite structure. In this structure, every thorium atom is at the centre of a cube and is surrounded by eight oxygen atoms situated at the corners of the cube. Each thorium atom replaced by a calcium has to result in an oxygen vacancy. This case is a good example of an ion vacancy of oxygen bound to a divalent impurity ion, namely calcium. For simplicity, the vacancy may be assumed to be confined to the first neighbour equivalent sites which are the corners of a cube. When there is no external field—mechanical or electrical—the vacancy will be jumping from one site to another in the first neighbour sites and has an equal occupation probability in respect of each one of them. When an external field is imposed, this equality of probability will be disturbed and a small deviation therefrom will set in. On removal of the field, the disturbed probability distribution decays into the equilibrium distribution. Hoffman<sup>2</sup> has pointed out that this decay for a finite system can in general be described with the help of a finite number of normal relaxation modes. A relaxation mode is a probability distribution for the vacancy which decays on all sites with the same characteristic decay or relaxation time. We may recall here that a general displacement mode for a finite set of particles bound to each other as a dynamical system can be described with the help of a finite number of normal vibrational modes. Haven<sup>3</sup> pointed out that there is a close analogy between the relaxation modes of a set of sites and vibrational modes of a molecule. The relaxation times correspond to normal frequencies and deviation of probabilities of occupation from equilibrium distribution corresponds to deviation of the atomic positions from the equilibrium ones. Just as the symmetry of atomic positions enable the application of group theory to a study of the normal modes of vibration, the symmetry of the system of sites accessible to the vacancy enables the application of group theory for classifying the relaxation modes.

The relaxation modes as well as the components of the external field can be classified as possessing the symmetry of one or other of the irreducible representations of the point group of the system of sites under consideration. It follows that a particular external field can cause relaxation, if only there is a mode which has the same symmetry. The subject has recently been deve-

loped in some detail by Wachtman<sup>4</sup> and by Bhagavantam and Pantulu.<sup>5</sup> When the point defect is free to move on all the equivalent sites throughout the crystal, it is called a free defect. The mechanical relaxation effect caused by such defects can be studied by extending the methods applied to bound or trapped point defects in the same way in which studies on the normal vibrations of molecules have been extended to study such vibrations in crystals.

#### 4. EXAMPLE OF $\text{ThO}_2$ - $\text{CaO}$ SYSTEM

It has been mentioned that  $\text{ThO}_2$ - $\text{CaO}$  system is a good example and that each thorium atom replaced by a calcium results in an oxygen vacancy. Among others, this system has recently been studied by Wachtman. If the oxygen vacancy is assumed to be trapped to the calcium located at the centre of a cube, the eight nearest neighbour oxygen sites, which the vacancy can occupy with equal probability in the absence of an external field, have the symmetry of the  $O_h$  group. The symmetry types of the irreducible representations in respect of this group, the representations under which the relaxation modes are possible and the manner in which the components of an external electric or mechanical field tensor can be classified have been given by Bhagavantam and Pantulu. One relaxation mode coming under  $F_{2u}$  which is a triply degenerate representation is found to be electrically active. Another mode coming under  $F_{2g}$  which is also a triply degenerate representation is mechanically active. There is a mode coming under  $A_{1u}$  which is neither mechanically active nor electrically active. The types  $F_{2u}$  and  $A_{1u}$  are antisymmetric and the type  $F_{2g}$  is symmetric with respect to the centre of inversion. These conclusions are similar to the results relating to normal modes of vibration in respect of a molecule with  $O_h$  symmetry, namely, that those coming under  $F_{2u}$  are active in infra-red absorption, those coming under  $F_{2g}$  are active in Raman scattering and those coming under  $A_{1u}$  are inactive in both infra-red absorption and Raman scattering. These conclusions have been reached by Wachtman and also by Bhagavantam and Pantulu. One can obtain the relaxation times as well in respect of these modes. The mode  $F_{2g}$  is estimated to have a relaxation time which is just twice that of the mode  $F_{2u}$ . That this is in fact so in calcium doped thorium oxide has been verified experimentally by Wachtman and his collaborators.

There are many other cases of significant practical importance which can be brought within the purview of such studies, but those are not discussed here. As has already been pointed out in the literature, there is a need for studying experimentally both the electrical and mechanical relaxation effects on the same samples of crystals. The close analogy that exists between the normal vibrations on the one hand and relaxation modes on the other also enables group theoretical methods which have already been successfully applied in the former case being extended to the latter as well. There is scope for extending such studies to investigate

the influence which defects in crystal lattices are likely to exert on a variety of physical properties particularly in relation to crystal symmetry.

1. Breckenridge, *Imperfections in Nearly Perfect Crystals*, Ed. W. Shockley, John Wiley & Sons, 1952.
2. Hoffman and Pfeiffer, *J. Chem. Phys.*, 1954, **22**, 132.
3. Haven and Van Santer, *Nuovo Cimento, Supplemento VII*, 1957, p. C05.
4. Wachtman, Jr., *Physical Review*, 1963, **131**, 517.
5. Bhagavantam and Pantulu, *Proc. Ind. Acad. Sci.*, 1963, **58**, 183.

## MOLECULAR HYDROGEN IN INTERSTELLAR SPACE

**E**XTENSIVE radio observations of our galaxy have shown that there are vast regions containing neutral atomic hydrogen at an average density of 1 atom/cm.<sup>3</sup> Also the 21-cm. scanning of interstellar space has given strong evidence that the hydrogen is distributed in dense "clouds" in which the density is about as much as 10 atoms/cm.<sup>3</sup>, and that these H I clouds fill roughly 10% of the interstellar space, their average kinetic temperature being about 100° K.

At this temperature hydrogen gas even at the low density of 10 atoms per cm.<sup>3</sup> would be almost completely molecular if thermal equilibrium existed. However, the conditions in H I clouds are very far from thermal equilibrium, and a gas initially purely atomic will be converted very slowly into molecular form.

In two theoretical papers contributed to the *Astrophysical Journal*, R. J. Gould, E. E. Salpeter and T. Gold discuss the various plausible processes whereby molecular hydrogen may be formed in interstellar space. The most efficient mechanism for the formation of H<sub>2</sub> is the catalytic process of recombination reaction on the surface of the interstellar grains, first suggested by van de Hulst. Interstellar grains appear to have physical properties that make them efficient catalysts for the formation of molecular hydrogen. Gould and Salpeter show that this process of association on the surface of the interstellar grains has a characteristic time possibly as short as 10<sup>8</sup> years, which is two orders of magnitude less than the age of the galaxy. Thus known physi-

cal processes can produce a high abundance of molecular hydrogen. However, at present, there is no easy way of detecting interstellar molecular hydrogen. Spectroscopic detection of interstellar H<sub>2</sub> is extremely difficult. The first bound excited electronic state of the molecule (11 ev.) gives absorption in the inaccessible ultra-violet. Being homopolar, the molecule has no permanent dipole moment, so that its pure vibration-rotation absorption is very weak. Moreover, the molecule has no fine or hyperfine structure splitting in the ground state, so that there can be no detection by radio emission analogous to that of the 21-cm. line of atomic hydrogen. Experiments in this direction, however, are underway which may prove successful. For example, The Princeton Observatory's spectroscope-carrying satellite to detect ultra-violet absorption lines; observation of near infra-red vibration-rotation radiation from H<sub>2</sub> near hot stars as suggested by Gould and Harwit.

If there is a high abundance of H<sub>2</sub> as is predicted by the present calculations of the authors, and also as has been suspected for nearly two decades, the H I clouds temperature is likely to be closer to 50° K.—since hydrogen molecule is an effective cooling agent—than to 100° K. as initially given by the 21-cm. investigators. In this connection it may be emphasized that the latest 21-cm. investigations by Radhakrishnan *et al.* actually do point to a lower temperature, and this may be taken as *weak* evidence for a high molecular abundance.—(*Astrophys. J.*, 1963, 138, 391.)

# FLUORESCENCE SPECTRUM OF URANYL ION IN NEUTRON IRRADIATED CAESIUM URANYL NITRATE

R. K. ASUNDI AND R. M. DIXIT

*Spectroscopy Division, Atomic Energy Establishment, Trombay, Bombay, India*

**I**N a communication from this laboratory<sup>1</sup> it was reported that when  $\text{CsUO}_2(\text{NO}_3)_3$  is subjected to the radiations of the Swimming Pool Reactor (Apsara) for 20 hours, it changed its colour, lost its characteristic spectrum, and for the first few weeks showed in fluorescence (1) a continuous band between 5550 Å and 6300 Å with a maximum at 5800 Å and (2) a very faint band at 4894 Å. In course of time the continuous band got weaker in intensity and the band at 4894 Å developed into a series of discrete bands extending to the longer wave side (Fig. 1). These bands consist of two

The fluorescence spectrum of a sample of  $\text{CsUO}_2(\text{NO}_3)_3$  prepared afresh showed the presence in it already (before irradiation) of the set of weak bands designated previously as sharp bands in addition to its usual characteristic strong bands (Fig. 2 A). On irradiation for periods ranging from 3 to 6 hours in the Apsara Reactor the characteristic bands almost disappeared whereas the sharp bands persisted with much increased intensity. An analysis of these well-developed bands was done and a comparison of the vibrational frequencies among themselves and with those of the mono-alkali

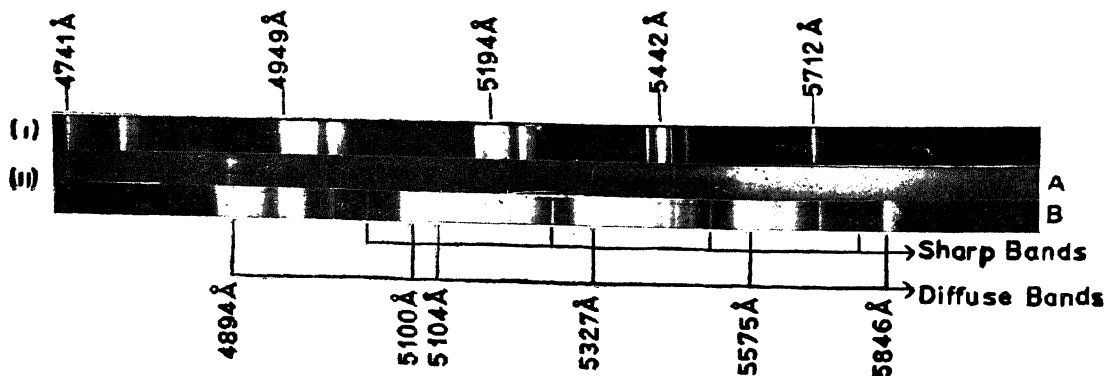


FIG. 1. (i) Fluorescence spectrum of unirradiated  $\text{CsUO}_2(\text{NO}_3)_3$ . (ii) (A) Fluorescence spectrum of 20 hr. reactor irradiated  $\text{CsUO}_2(\text{NO}_3)_3$  (Six weeks after irradiation). (iii) (B) Fluorescence spectrum of 20 hr. reactor irradiated  $\text{CsUO}_2(\text{NO}_3)_3$  (More than sixteen weeks after irradiation). (The dispersions for the three spectra are slightly different. All spectra were taken at 77° K.)

types; one a set of weak but sharp bands separated from one another by  $\sim 852 \text{ cm}^{-1}$ , and a set of diffuse bands showing two frequency differences of  $\sim 822 \text{ cm}^{-1}$  and  $\sim 840 \text{ cm}^{-1}$ . Both types of bands thus involve vibrational frequencies of an order of magnitude which could still be attributed to  $\text{UO}_2$  in altered surroundings. A discussion of these and other observed phenomena will be found in the previous communication.

Further investigations on this subject have now brought to light the fact that the set of sharp bands are due to the uranyl ion in the di-alkali salt,  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ . There is also spectroscopic evidence to show that the diffuse bands may probably be due to the ion in the tri-alkali salt,  $\text{Cs}_3\text{UO}_2(\text{NO}_3)_5$ .

salt indicated a close parallelism to similar comparison of the known frequencies in the mono- and di-rubidium uranyl nitrates. This led to the possibility that the sharp bands obtained with increased intensity after irradiation of the mono-alkali salt might be due to the di-alkali salt. Accordingly a sample of di-caesium uranyl nitrate was prepared and its fluorescence spectrum studied.<sup>2</sup> This agrees entirely with the fluorescence spectrum of the irradiated mono-caesium uranyl nitrate (Fig. 2 B, C).

It should be noted that the sample of caesium uranyl nitrate irradiated for 3 to 6 hours does not show the set of diffuse bands previously observed under long irradiation. The characteristic bands of  $\text{CsUO}_2(\text{NO}_3)_3$  are also very

weak. Its spectrum consists essentially of bands which are identified as those due to the di-cæsium uranyl nitrate (Fig. 2, B) and the weak continuous band with a maximum at  $\sim 5800 \text{ \AA}$  (not shown in the figure).

does not bring about the changes in the fluorescence spectrum of  $\text{UO}_2^{++}$  reported here. A detailed investigation of these and related phenomena is under way and the results will be forwarded for publication in due course.

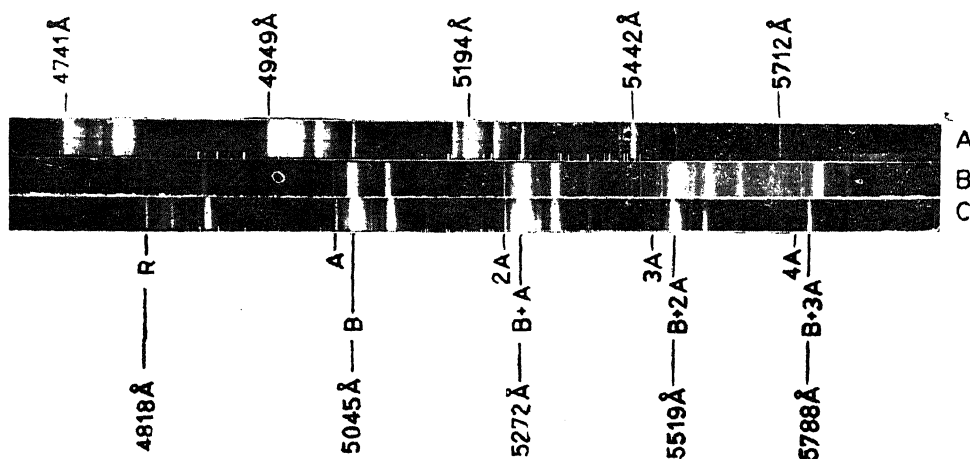


FIG. 2. (A) Fluorescence spectrum of unirradiated  $\text{CsUO}_2(\text{NO}_3)_3$ . (B) Fluorescence spectrum of 3 hr. reactor irradiated  $\text{CsUO}_2(\text{NO}_3)_3$ . (C) Fluorescence spectrum of synthesized  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ . (The dispersions for the three spectra are slightly different. All spectra are taken at  $77^\circ \text{ K.}$ )

The set of diffuse bands observed in the sample of  $\text{CsUO}_2(\text{NO}_3)_3$  irradiated for 20 hours (Fig. 1, B) have been photographed with increased time of exposure. An analysis of these much diffuse bands shows that they form a system with  $20428 \text{ cm}^{-1}$  as the resonance band,  $\sim 825 \text{ cm}^{-1}$  as the totally symmetric vibration A, and  $\sim 840 \text{ cm}^{-1}$  as the antisymmetric vibration B. Infra-red data discussed previously<sup>1</sup> of the irradiated salt showing a strong band at  $847 \text{ cm}^{-1}$  and a weak one at  $825 \text{ cm}^{-1}$  support this analysis. Table I gives certain relevant relations between the frequencies of different mono-, di- and tri-(?) alkali uranyl salts. This indicates that the diffuse bands may probably be due to tricæsium uranyl nitrate.

TABLE I  
Uranyl ion

(a) Ratios of frequencies B : A in mono-, di- and tri-cæsium nitrates				
	Cs	Cs <sub>2</sub>	Cs <sub>3</sub>	(?)
B (Antisym.)	1.08 <sub>1</sub>	1.09 <sub>2</sub>	1.02 <sub>7</sub>	
A (Sym.)				
(b) Ratios of vibration frequencies in mono-, di- and tri-alkali nitrate salts				
	K : K <sub>2</sub>	Rb : Rb <sub>2</sub>	Cs : Cs <sub>2</sub>	Cs <sub>2</sub> : Cs <sub>3</sub>
A (Sym.)	1.00 <sub>6</sub>	1.03 <sub>1</sub>	1.03 <sub>2</sub>	1.03 <sub>7</sub>
B (Antisym.)	1.00 <sub>4</sub>	1.02 <sub>6</sub>	1.02 <sub>2</sub>	1.11 <sub>4</sub>
(c) Difference in resonance energies in mono-, di- and tri-cæsium nitrates				
	$R_{\text{mono}} - R_{\text{di}} = 21089 - 20751 = 331 \text{ cm}^{-1}$			
	$R_{\text{di}} - R_{\text{tri}} = 20751 - 20428 = 323 \text{ cm}^{-1}$			

Irradiation of cæsium uranyl nitrate by a non-reactor source of fast neutrons of energy  $\sim 14 \text{ Mev.}$  also produces the effects described above. But irradiation by gamma-rays or slight irradiation by accelerated electrons ( $\sim 4 \text{ Mev.}$ )

1. Asundi R. K., Singh, S. and Narasimham, N. A., *Proceedings of Symposium on 'Nuclear and Radiation Chemistry'*, Indian Chemical Society, Calcutta 9, India, 1960, pp. 163-70.
2. — and Dixit, R. M., *Nature*, 1963, 200, 668.

## RADIOCARBON DATES OF ARCHAEOLOGICAL SAMPLES

D. P. AGRAWAL, S. KUSUMGAR AND R. P. SARNA

(Tata Institute of Fundamental Research, Bombay-5)

IN this paper are reported the measured *radio-carbon dates* of several archaeological samples using the acetylene synthesis method (Suess, 1954). The techniques used for the measurement of radiocarbon activity of samples and the principle of radiocarbon method, developed by Libby and his co-workers, have been dealt with in some detail in a previous publication from this laboratory (Kusumgar *et al.*, 1963 a).

The *radiocarbon dates* are calculated on the basis of a 95% net activity of the oxalic acid standard, supplied by the National Bureau of Standards, as the age-corrected value for pre-1900 wood. This standard has been internationally accepted by most radiocarbon laboratories (Godwin, 1959).

Two dates are given for each sample. The first date is based on the value of  $5568 \pm 30$  yrs. for the half-life of radiocarbon; the second date, given within parenthesis, is calculated on the basis of a recently measured half-life value,  $5730 \pm 40$  yrs. Though the latter seems to be a better working value, as discussed at the V<sup>th</sup> International Radiocarbon Conference (Godwin, 1962), no international agreement has been reached as yet on a final half-life value. It is important that all intercomparisons should be based on dates calculated using a particular half-life value only. All dates given are in years B.P.; for converting them to A.D./B.C.; 1950 A.D. should be used as the reference year (Flint *et al.*, 1962).

All samples were given an initial treatment before processing through various chemical steps for the synthesis of acetylene from the sample carbon in order to remove extraneous intrusions. The samples were carefully inspected and cleaned of foreign objects such as mud grains, rootlets, etc. The samples were then treated with dilute HCl and subsequently boiled in a dilute NaOH solution to get rid of any humic acid present. NaOH pretreatment was avoided when the sample was too soft and expected to disintegrate.

The sites from where the samples\* derived have been arranged in an alphabetical order.

\* Samples for radiocarbon dating are accepted by the Radiocarbon Laboratory of the Institute which has been set up primarily as a national facility for archaeological research. All enquiries should be addressed to the Secretary, Radiocarbon Dating Committee, Tata Institute of Fundamental Research, Colaba, Bombay-5.

Where more than one sample was measured from the same site, the samples have been described in the order of increasing archaeological ages. Approximately contemporary samples have been arranged on the basis of increasing  $C^{14}$  dates only.

## A BRIEF DISCUSSION OF DATES

A large number of samples have been measured from Hastinapur. The  $C^{14}$  dates for the P.G. Ware Culture are in good agreement with Wheeler's date bracket of *ca.* 800-500 B.C. (Wheeler, 1959), thus falling little short of Lal's estimate (Lal, 1954, 1955). More measurements are, however, necessary to define the time-spread of P.G. Ware.

Two samples from Kausambi appear to be systematically younger by a couple of hundred years compared to archaeological estimates.

The date on one sample from Mohenjodaro is in good agreement with the archaeological estimate (Piggot, 1961). Similarly, the single date for Kudan is also in good agreement. For Rajar Dhibi no definite basis for archaeological dating exists. The solitary dated sample, deriving from the latest period of the site, will have to be followed up by a number of measurements to define the chronological frame-work for the site.

The remaining dates are for samples deriving from Nagarjunakonda, Adichanallur, Mohanur and Alamgirpur. Except for the Adichanallur sample (wood) which was kept impregnated with wax in the museum for *ca.* 60 years, others are bones. All the  $C^{14}$  dates for these samples are in complete disagreement with the archaeological estimates. The work of several radiocarbon laboratories has shown that radiocarbon dates of bone samples are usually not reliable as their carbon is easily exchanged by the passage of substratum water containing dissolved limestone or atmospheric carbon-dioxide. Furthermore, the samples in question were not specifically collected for radiocarbon dating and some doubt has been expressed by archaeologists as regards to their identity.

A list of all dates measured prior to this work has already been published (Kusumgar *et al.*, 1963 b). It is proposed that as and when sufficient new radiocarbon dates of the Institute become available, they will be periodically presented in this journal. An annual compilation of all dates is submitted regularly

to the journal *Radiocarbon* where dates from all radiocarbon laboratories are published.

#### ACKNOWLEDGEMENTS

At every stage of the work authors received active guidance from Prof. D. Lal to whom they are beholden. Thanks are also due to Shri A. Ghosh, Dr. H. D. Sankalia, Shri B. B. Lal and Shri B. K. Thapar for archaeological discussions.

#### C<sup>14</sup> DATES WITH SAMPLE DESCRIPTIONS

##### *Adichanallur, Madras, India*

*TF-70 Burials, 775 ± 95 (795 ± 95)*

Wood sample from Adichanallur (Lat. 8° 50' N., Long. 76° 40' E.), Tinnevely District, Madras. The site was excavated during 1899-1905. The sample had been stored after soaking in wax. Sample submitted by Shri Satyamurti. Wood pieces were boiled in hot water. NaOH pretreatment was also given.

The date obtained is in wide divergence from the archaeological estimates, as the sample is supposed to be associated with urn-burials.

##### *Alamgirpur, U.P., India*

*TF-51 Bone Sample, 1060 ± 95 (1090 ± 100)*

A composite of three samples believed to have been derived from the P.G. Ware deposit of the site, Alamgirpur (Lat. 30° 45' N., Long. 75° 50' E.), District Meerut, U.P. Sample was submitted by Shri A. Ghosh.

The date obtained is at considerable variance with the archaeological estimate. Because such a large contamination is unlikely and also as from the sections the samples appear to belong to disturbed strata, the possibility of a wrong identification of the levels cannot be ruled out.

##### *Hastinapur, Uttar Pradesh, India*

Hastinapur (Lat. 29° 9' N., Long. 78° 3' E.) is located on the left bank of Ganga River in Meerut District. The site was excavated by Shri B. B. Lal, Director, School of Archaeology, in 1950-52 and 1962. The samples presented in this paper belong to the Periods II and III of the site. The excavator has suggested an association of Aryans with the P.G. Ware industry of Period II. Samples submitted by Shri A. Ghosh.

The five dates presented here have an internal consistency borne out by the stratigraphic sequence of the site. The C<sup>14</sup> measurements suggest the spread of Period III between ca. 400 and ca. 100 B.C. And there does not appear much gap between the end of Period II and the beginning of Period III. It is highly

desirable to obtain more C<sup>14</sup> measurements for these crucial periods in Indian archaeology to define the chronologies of N.B.P. and P.G. Wares.

*TF-80, 82, Period III, 1940 ± 110 (2000 ± 110)*

A composite of two samples of charcoal (mixed with earth) from Trench HST-1/1962 (Northern extension), Locus G-H, Layer 23, Field Nos. HST/62/C/1 and 4, Depth 3.9 m. below surface. The samples derived from identical depths and layers. The sample is believed to belong to the end of Period III.

*TF-88, Period III, 2225 ± 110 (2290 ± 110)*

Charcoal sample (mixed with earth) from Trench HST-1/1962, Locus XCIV-XCVII, Layer 25, Field No. HST/62/C/15, Depth 6.45 m. below surface. The sample is from the lowest layer of Period III which marks the beginning of N.B.P.-ware. (Some rootlets were visible in the sample.)

*TF-83, Period II, 2220 ± 110 (2285 ± 110)*

Charcoal sample (mixed with earth) from Trench HST 1/1962, Locus XCIV-XCVII, Layer 26, and Pit Y sealed by Layer 25, Field No. HST/62/C/6, Depth 6.75 m. below surface. The sample derives from the uppermost layer of Period II marking the end of Painted Greyware. (A few rootlets were visible in the sample.)

*TF-90, Period II, 2270 ± 110 (2335 ± 110)*

Charcoal (mixed with earth) from Trench HST-1/1962, Locus XCIV-XCVII, Layer 26, Field No. HST/62/C/17, Depth 6.6 m. below surface. The sample is from the same layer as TF-83.

*TF-85, Period II, 2385 ± 125 (2455 ± 130)*

Charcoal (mixed with earth) from Trench HST-1/1962, Locus XC-XCIV, Layer 28 and Pit Z which is sealed by Layer 27, Field No. HST/62/C/10, Depth 7.25 m. to 7.45 m. below surface. The sample belongs to the late levels of Period II. (A few rootlets visible in the sample.)

##### *Kausambi, Uttar Pradesh, India*

Kausambi (Lat. 81° 23' N., Long. 25° 20' E.), modern Kosam, is situated on the northern bank of Yamuna. According to the Puranas, the Capital of the Pandavas was shifted from Hastinapur to Kausambi at the time of Nichaksu, fifth in descent from Parikshit, the grandson of Arjuna. The site is being excavated every year since a decade by the Allahabad University under the direction of Prof. G. R. Sharma who submitted these samples.

TF-93, *Early Roads*,  $1655 \pm 105$  ( $1705 \pm 110$ )

Charcoal (mixed with earth) from Kausambi, Allahabad District, Trench KSB-I-III-RD, Locus 3-5, Layer 4, Field No. KSB/63/AP-1, Depth 1.25 m. below surface. (A few rootlets were visible in the sample.)

TF-97, *Early Road*,  $1640 \pm 105$  ( $1690 \pm 110$ )

Charcoal (mixed with earth) from Trench KSB-I-III-RD, Locus 2-5, Layer 6, Field No. KSB/63/AP-5, Depth 1.65 m. to 1.7 m. below surface. (A few rootlets were visible in the sample.)

#### Kudan, Nepal

TF-62, *Early Medieval Temple*, Kudan :

TF-62 a,  $1020 \pm 100$  ( $1055 \pm 105$ )

TF-62 b,  $850 \pm 95$  ( $875 \pm 100$ )

$935 \pm 70$  ( $965 \pm 75$ )

Charred wood (mixed with earth) from Kudan (Lat.  $27^{\circ} 32' N.$ , Long.  $83^{\circ} 2' E.$ ). Layer 3, Depth 1.55 m., Field No. Kudan D-6, from a temple door-frame. Sample treated with HCl and NaOH. (Some visible rootlets were present in the sample.) Sample submitted by Shri A. Ghosh.

#### Mohanur, Madras, India

TF-77, *Burials*,  $330 \pm 100$  ( $340 \pm 105$ )

Bone sample from Mohanur (Lat.  $10^{\circ} 30' N.$ , Long.  $79^{\circ} 05' E.$ ), Salem District. The sample is believed to have derived from the accidental discovery of the "vestigeal urn-burials" on the banks of Kaveri River. Sample submitted by Shri Satyamurti, State Museum, Madras.

#### Mohenjodaro, West Pakistan

TF-75, *Harappa Cultured*,  $3600 \pm 110$  ( $3705 \pm 115$ )

Clean charred grain from Mohenjodaro (Lat.  $27^{\circ} 19' N.$ , Long.  $68^{\circ} 8' E.$ ), Sind. Locus: Chamber 60, Block-2, from the pavement of a 'late date', Depth 1.27 m. below datum, Field No. L 855, as recorded in Marshall's report. Since 1925 A.D. the sample was kept in a glass bottle in the Safdarjang collection, New Delhi. Sample submitted by Shri A. Ghosh.

This is the first radiocarbon date for the late Harappan levels of Mohenjodaro.

#### Nagarjunakonda, Andhra Pradesh, India

The extensive site of Nagarjunakonda (Lat.  $16^{\circ} 31' N.$ , Long.  $79^{\circ} 14' N.$ ), is situated in Guntur District. Excavations were conducted by Dr. Subrahmanyam of the Survey during 1954-61 (Ghosh, 1953-61). The samples described below are believed to have all derived from the Neolithic cemetery (ca. 2000 B.C.). Samples were submitted by Shri A. Ghosh.

The  $C^{14}$  dates obtained are in complete disagreement with the archaeological estimates. Reasons for this discrepancy have been discussed in the text.

TF-73 *Burials*,  $1495 \pm 105$  ( $1535 \pm 110$ )

Soft and spongy human bones from the Neolithic cemetery. Grave No. 4, Skeleton No. 6, Depth 40 cm. below surface.

TF-72 *Burials*,  $1525 \pm 95$  ( $1570 \pm 100$ )

Soft and spongy human bones from the Neolithic cemetery. Grave No. 6, Skeleton No. 8, Depth 52 cm. below surface.

TF-30 *Burials*,  $1535 \pm 95$  ( $1580 \pm 100$ )

Animal bones laden with ash from a Neolithic pit No. 44, Site 46, Sector NV, Division 362, Trench A 3, 1.2 m. to 1.5 m. below surface.

TF-63 b *Burials*,  $1750 \pm 100$  ( $1805 \pm 105$ )

Soft and spongy human bones from the Neolithic cemetery, Grave No. 5, Skeleton No. 7, Depth 35 cm. below surface.

TF-74 *Burials*,  $1900 \pm 95$  ( $1955 \pm 100$ )

Soft and spongy human bones from Neolithic cemetery. Grave No. 8, Skeleton No. 10, 50 cm. below surface.

#### Rajar Dhibi, West Bengal, India

TF-61, *Period V*,  $1230 \pm 105$  ( $1260 \pm 110$ )

Charcoal sample (mixed with soil) from Rajar Dhibi (Lat.  $23^{\circ} 34' N.$ , Long.  $87^{\circ} 39' E.$ ), from Burdwan District, W.B., Trench No. RDB IV, Locus: O-II, Depth 1 m., Layer 2 C. Submitted by Shri P. Dasgupta.

Sample was also treated with NaOH. (Traces of rootlets were present in the sample.)

This is the first time that the latest period of this culture has been dated. No definite datable archaeological evidence seems to be available at present to determine the chronology of these cultures of West Bengal.

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## LETTERS TO THE EDITOR

### NOTE ON M 4 TRANSITIONS

THE prediction of M 4 transitions has been one of the biggest triumphs of the Independent particle model.<sup>1</sup> According to this model M 4 transitions should occur in islands characterised by neutron or proton numbers 38–50, 64–82 and near 126. This is the region where transitions of the type  $g_{9/2} \rightleftharpoons p_{1/2}$ ,  $h_{11/2} \rightleftharpoons d_{3/2}$ , and  $i_{13/2} \rightleftharpoons f_{5/2}$  occur, respectively. According to the calculations of Moszkowski<sup>2</sup> the transition probability for an odd-proton transition should be nearly twice that for the odd-neutron transition. Goldhaber and Sunyar<sup>3</sup> carried out an excellent survey of the M 4 transitions known up to 1955 and concluded that there is no difference between odd-proton and odd-neutron transition.

The availability of more extensive data since 1955 has prompted us to re-examine this point.

In Table I we have collected the relevant M 4 transitions. Group A represents transitions of

TABLE I

Group A $g_{9/2} \rightleftharpoons p_{1/2}$				
Nucleus	Energy (Mev.)	Obsd. Mean life Sec.	M <sup>2</sup>	Reference
<sup>38</sup> Sr <sub>49</sub> <sup>87</sup>	0.390	$1.588 \times 10^4$	4.107	c
<sup>49</sup> In <sub>64</sub> <sup>113</sup>	0.390	$1.27 \times 10^4$	3.261	c
<sup>49</sup> In <sub>66</sub> <sup>115</sup>	0.335	$4.554 \times 10^4$	3.455	c
<sup>30</sup> Zn <sub>39</sub> <sup>69</sup>	0.439	$7.667 \times 10^4$	3.146	c
<sup>39</sup> Y <sub>50</sub> <sup>89</sup>	0.913	23.16	128.8	c
<sup>39</sup> Y <sub>52</sub> <sup>91</sup>	0.555	$4.358 \times 10^3$	3.064	c
Group B $h_{11/2} \rightleftharpoons d_{3/2}$				
<sup>54</sup> Xe <sub>77</sub> <sup>131</sup>	0.1636	$7.51 \times 10^7$	3.7	a
<sup>56</sup> Ba <sub>77</sub> <sup>133</sup>	0.288	$1.651 \times 10^6$	4.84	b
<sup>77</sup> Ir <sub>116</sub> <sup>193</sup>	0.080	$3.116 \times 10^9$	163.2	b

#### References for Table I

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the type  $g_{9/2} \rightleftharpoons p_{1/2}$  and Group B transitions of the type  $h_{11/2} \rightleftharpoons d_{3/2}$ . Unfortunately, the third type cannot be considered since no odd-proton transitions corresponding to the neutron types are available. The first column gives the nucleus, the second the energy of the transition in Mev., the third the mean-life in sec. and the last column the quantity M<sup>2</sup>, the square of the radial matrix element for the transition. M<sup>2</sup> was calculated from the formula<sup>2</sup>

$$M^2 = \frac{1}{\tau_\gamma C(M, l) A^2 E_\gamma^9 S}$$

where

A = mass number,

E<sub>γ</sub> = the energy in Mev.,

S = the statistical factor and

C(M, l) =  $1.81 \times 10^{-6}$  for M 4 transitions.

The value of S is

$$\begin{aligned} S &= 1 && \text{for } 9/2 \rightarrow 1/2 \\ &= 5 && \text{for } 1/2 \rightarrow 9/2 \\ &= 15/11 && \text{for } 11/2 \rightarrow 3/2. \end{aligned}$$

A striking feature is the dependence of the matrix element on the 9th power of the transition energy.

From an examination of Table I we make the following observations:

1. In Group A the matrix elements for odd-proton are essentially the same as for the odd-neutron with the exception of <sup>39</sup>Y<sub>50</sub><sup>89</sup> for which the odd-proton value is several times larger than the corresponding odd-neutron value. This may be attributed to the influence of closed shell at 50, although Goldhaber and Sunyar<sup>3</sup> could not find evidence of such an effect.

2. In Group B we again note that the odd-proton M<sup>2</sup> value is several times larger than the odd-neutron value. However, in this case the explanation must come from other than shell effect.

Summarising, we may say that we have found examples where the odd-proton value is much larger than twice the neutron value expected from Moszkowski's estimates. Configuration mixing calculations similar to those done by Lawson and Gupta<sup>4</sup> cannot be expected to explain these observations.

Dept. of Physics,  
Karnatak University,  
Dharwar-3, May 2, 1963.

S. M. BRAHMAVAR.  
M. K. RAMASWAMY.

(D. S. N. M.) is thankful to the C.S.I.R. for the  
award of a Research Fellowship.

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### ABSORPTION SPECTRUM OF TRIBENZYLAMINE

THE near ultraviolet absorption spectrum of tribenzylamine of space group  $C_{2h}^5$ , which was previously studied only in solution,<sup>1,2</sup> has been photographed in the solid state (1) in the form of a thin melt pressed between two quartz plates, (2) of thin flakes obtained from alcohol solution at 30° C. and at liquid oxygen temperature and also in the vapour phase (75 cm. column) between 30° C. and 160° C. The melt gave a very intense and broad absorption system consisting of six bands at 30° C. and an additional band at  $\lambda$  2591 Å at liquid oxygen temperature. When the thickness of the melt is increased, the spectrum of the thicker flakes presented a total absorption beginning at  $\lambda$  3900 Å.

Taking the origin of the electronic transition giving rise to this band system as  $\nu$  37020  $\text{cm}^{-1}$ , the bands could be analysed in terms of three upper state vibrational frequencies 551, 1013 and 1414  $\text{cm}^{-1}$ , characteristic of the molecule. The microphotometer trace of the spectrum taken at liquid oxygen temperature is given in Fig. 1. The frequency 1819  $\text{cm}^{-1}$  may be taken either as a fundamental or a combination frequency.

From the intensity of the band system, it may be taken that the electronic transition is an allowed type. Two of the upper state frequencies 551 and 1013  $\text{cm}^{-1}$  are comparable with those obtained in benzylamine studied by Banerjee<sup>3</sup> under different conditions. The frequency 551 may be due to one of the components of 606  $\text{cm}^{-1}$ , the  $e_{2g}$  mode of benzene ring vibration and 1013  $\text{cm}^{-1}$ , the breathing vibration. The fundamental 1414 may represent a C-C stretching mode. The electronic transition may be that corresponding to the benzene forbidden transition  $^1A_1 - ^1B_{2g}$  made allowed by the reduction in symmetry.

We record our thanks to Prof. K. Rangadhama Rao for helpful suggestions. One of us

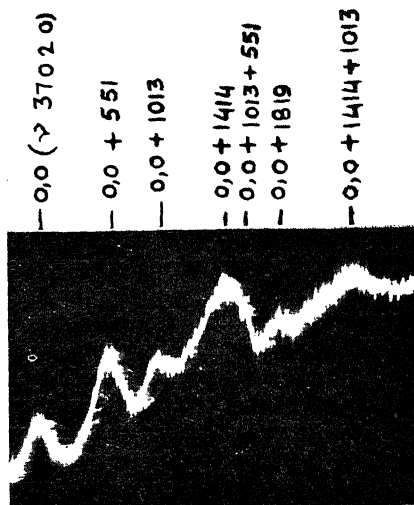


FIG. 1

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November 8, 1963.

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### STANDARD IDEALS IN LATTICES

THIS note deals with some of the problems posed by G. Gratzner and E. T. Schmidt in their paper "Standard Ideals in Lattices", *Acta Math. Acad. Sci. Hung.* (1961). The results are announced without proof. Details of proofs and examples will be published in due course. Five of the problems (1, 5, 13, 15 and 17) of the paper cited above are tackled here. Conjectures 1, 5, and 17 are shown to be false, by examples. Problem 15 is shown to be insignificant. For problem 13 conditions are given.

**Problem 1.**—Is the standardness of an ideal  $S$  of a lattice  $L$  equivalent to the conditions: (i)  $S + XY = (S + X)(S + Y)$  and (ii)  $S + X = S + Y$ ;  $SX = SY$  imply  $X = Y$  for all principal ideals  $X, Y$  of  $L$ . We give an example of a lattice and prove it in the negative.

**Problem 5.**—Is a distributive ideal (or at least a standard ideal) of a weakly modular lattice neutral? With examples of suitable weakly modular lattices we show that a distributive ideal of a weakly modular lattice need not always be standard and a standard

ideal of weakly modular lattice need not always be neutral.

**Problem 17.**—Is an element  $n$  of a weakly modular lattice  $L$  neutral in  $(nx, n+x)$  for all  $x$  in  $L$  if and only if  $n$  is neutral in  $L$ ?

This is proved to be false with the help of an example.

**Problem 15.**—Let degree  $m$  (an infinite or finite cardinal) of non-distributivity of the modular lattice  $L$  be defined as the power of a subset  $H$  of  $L$  maximal with respect to the property that any three elements of  $H$  generate a non-distributive sublattice of  $L$ . Is  $m$  an invariant of the lattice? etc.

We have an example of a lattice  $L$  in which there is a three-element subset  $H_1$  and a different four-element subset  $H_2$  such that each is maximal with respect to the property that any three elements of  $H_1$  generate a non-distributive sublattice of  $L$ . Hence the degree of non-distributivity of a lattice as defined in the problem above is not well defined.

**Problem 13.**—Describe those finite lattices in which we get a one-to-one correspondence between the homomorphisms and standard ideals, letting a homomorphism correspond to its kernel.

We show that a set of necessary and sufficient conditions for a one-to-one correspondence between standard ideals on any lattice  $L$  with zero (finite or infinite) is that  $L$  is a lattice such that given  $p = (x, y)$  ( $x > y$ ) there exists an element  $s$  in  $L$  with  $s \equiv 0$  ( $\theta_p$ ) and  $x = y + s$  ( $\theta_p$  is the congruence generated by the interval  $p$ ).

Mathematics Dept.,  
University of Madras,  
November 4, 1963.

IQBALUNNISA.

### CARCINOGENICITY OF 3-METHYL-2-NAPHTHYLAMINE

2-NAPHTHYLAMINE is one of the important dye intermediates, but its production and handling have been banned in several countries including India because of its carcinogenic action.<sup>1-4</sup> Its C-methyl derivative, 3-methyl-2-naphthylamine, known<sup>5</sup> since 1934, has now been synthesised<sup>6</sup> by a new process by the Hyman Laboratories (U.S.A.). On account of the known carcinogenicity of its parent compound, it was referred to us by Dr. K. Venkataraman, Director, National Chemical Laboratory, Poona, for testing whether it is free from carcinogenic hazard, there being a special need of an azoic coupling component by the Indian Textile Industry. Preliminary

results of the study have been presented in this communication.

Three batches, each one consisting of 8 male mice (Swiss strain, 12-14 weeks old) were taken and mice from batch (I) were subcutaneously injected with 3% solution (0.1 ml.) of 3-methyl-2-naphthylamine in refined groundnut oil, twice a week. The mice in batch (II) were given equal quantity of the same percentage solution of 2-naphthylamine in the same solvent; while the control mice, batch (III), were given 0.1 ml. of the groundnut oil, by the same route. All the animals were maintained on the colony diet and given water *ad libitum*. The mice from batch (I) developed solid tumours in the subcutis. The average latent period of the palpable tumour was 120 days from the day the injections were started and the percentage of tumour incidence was 87.5. Histological study of the mouse tumour tissues revealed them to be fibrosarcomas (Fig. 1). The average tumour



FIG. 1. Mouse Fibrosarcoma.

weight was 7.4 gm. The tumour is transplantable into mice of the same strain. Mice treated with either 2-naphthylamine or with groundnut oil alone did not, however, show any evidence of palpable tumour during the period.

Similar experiments on 3 batches of rats (Wistar strain, 10 weeks old) were carried out. A batch of 8 female rats, each receiving subcutaneous injections of 3-methyl-2-naphthylamine (3% solution in refined groundnut oil; 5 mg./100 gm. body wt./twice a week) showed 100% incidence of tumours in the animals. Average tumour weight was found to be 33.1 gm. The latent period of palpable tumour in rats treated with 3-methyl-2-naphthylamine was 126 days. Histological study of rat tumour tissues showed them to be mostly carcinomas (Fig. 2),

The tumour could also be serially transplanted in the same strain of rats.

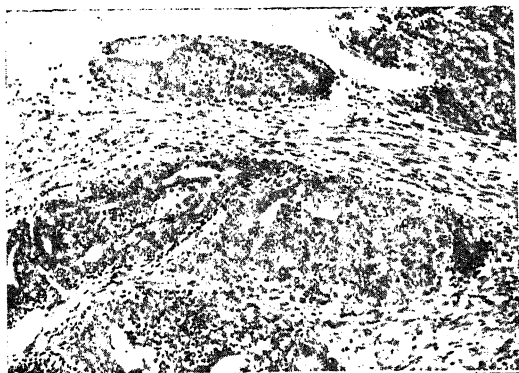


FIG. 2. Rat Carcinoma.

The above results indicate that 3-methyl-2-naphthylamine is a potent and direct carcinogen and in fact more dangerous than 2-naphthylamine. A full paper on the carcinogenicity of 3-methyl-2-naphthylamine will be published in due course elsewhere.

The authors are indebted to Dr. G. V. Talwalkar, Assistant Pathologist, Tata Memorial Hospital, Bombay 12, for the histological examination of the tissue slides and to Shri R. V. Nerurkar for the preparation of the slides.

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#### DRIERS FROM THE FATTY OIL OF *HYDNOCARPUS WIGHTIANA* BLUME

NAPHTHENATES are now widely used as driers in the surface coating industry due to their unique property of high solubility in common solvents and good compatibility with most of the organic coating compositions. Naphthenic acid from which the naphthenates are prepared is a product of coal-tar distillation, and is an imported material at present. It is reported to contain a cyclopentane ring with a side-chain of  $C_3$  to  $C_5$  atoms with a double bond. If driers similar to naphthenates could be made avail-

able from indigenous sources, it would be considered as a welcome development in the coating industry of this country.

From this point of view it was thought that the use of the non-edible oil from *Hydnocarpus wightiana*, an indigenous plant product containing mainly the glycerides of hydnocarpic, chaulmoogric and gorlic acids with structures similar to naphthenic acid, for the preparation of driers, might help to some extent to substitute the naphthenates.

*Hydnocarpus wightiana*, which is available in abundance<sup>3</sup> in certain parts of our country on the Western Coast from South Konkan to Travancore, Himalayan regions, Bengal and Bihar, yields a non-edible fatty oil which has been chiefly used in the Ayurvedic system of medicine as a cure for leprosy and other skin disorders. It contains the glycerides of hydnocarpic, chaulmoogric<sup>4</sup> and gorlic acids which constitute 85% to 90% of the oil and 10% to 15% glycerides of oleic, palmitic and lower homologues of chaulmoogric acid. Hydnocarpic, chaulmoogric and gorlic acids contain cyclopentene ring along with a side-chain of  $C_{11}$  and  $C_{13}$  atoms respectively; whereas gorlic acid which also contains  $C_{13}$  atoms in its side-chain has, in addition, a double bond between  $C_7$  and  $C_8$  atoms in the chain. Thus the fatty acids present in this oil have structures very similar to the naphthenic acid and hence are expected to give driers having drying performance similar to those of naphthenates.

The fatty acids from *Hydnocarpus wightiana* Oil (HWFA) were obtained by the conventional process and were used for the preparation of driers. The driers, namely, the naphthenates and hydnocarpates *cum* chaulmoogrates of cobalt, manganese and lead were prepared by a method, based on the process described by Marwedel.<sup>1,2</sup> These driers were then analysed and tested by incorporating them in appropriate amounts with coating compositions such as raw linseed oil, linseed stand oil, linseed pentaerythritol modified long oil alkyd resin and white synthetic enamel.

The cobalt hydnocarpate gave performance which is comparable with cobalt naphthenate. The solubility and compatibility of the drier were comparable with those of the naphthenate. The storage stability was found even superior to the linoleates and other conventional driers. The colour of cobalt hydnocarpate was paler than that of cobalt naphthenate. Similar results were obtained in the case of *Mn*-driers of HWFA, hydnocarpic acid rich fraction and

chaulmoogric acid rich fraction, with slightly superior water resistance.

In general, these hydnocarpate-chaulmoograte driers are comparable with naphthenates except for their lead derivatives which are only comparable with linoleates in their performance. The details will be shortly published as a paper.

Dept. of Chemical Technology,  
Bombay-19. March 11, 1963.

N. H. PURANDARE.

S. V. PUNTAMBEKAR.

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### CHEMICAL CONSTITUTION AND PHYSIOLOGICAL ACTIVITY IN SOME SUBSTITUTED FLAVONES

2-PHENYL and 3-phenyl chromones are toxic to fish, although feeble in character. Among these, 7-methoxy flavone is markedly toxic,<sup>1</sup> compared to simple isoflavones. 7-Methoxy, 7-methoxy-8-allyl and 7-allyloxy-2-methyl isoflavones<sup>2</sup> and 7-dimethylallyloxy-3':4'-dimethoxy-2-methyl, 7-allyloxy-3':4'-dimethoxy-2-methyl isoflavones<sup>3</sup> possess appreciable toxicity. With a view to studying the effect of alkyl and aryl substituents in the 3 position of flavones and also to compare their toxicities with the corresponding isoflavone derivatives, 3-methyl, 3-ethyl, 3-phenyl and simple flavones have been synthesised and tested for toxicity, adopting the method of Krishnaswamy and Seshadri<sup>3</sup> using the fish *Barbus ticto*.

Most of the compounds used for testing have been obtained by the simplified Baker-Venkataraman transformation.<sup>4</sup> This method essentially consists of condensation of O-hydroxy acetophenones with aroyl chlorides in acetone medium in the presence of dry potassium carbonate, followed by refluxing with either alcoholic potassium hydroxide or aqueous-alcoholic potassium carbonate solution. The reaction is very facile and the over-all yields

are high. 7-Hydroxy-4'-methoxy-3-methyl flavone and 7-hydroxy-2:3-diphenyl chromone have been, however, synthesised by Kostanecki-Robinson reaction and by the method adopted by Gupta and Seshadri<sup>5</sup> respectively. Details of their synthesis will be published elsewhere.

The fish toxicity data of these flavones are given in Table I and those of isoflavones already reported in literature in Table II.

TABLE I

Compound	Concentration (p.p.m.)	Turning time (in minutes)	Remarks
A. Flavones			
1. 7-methoxy <sup>1</sup>	20	2.70	..
7-methoxy <sup>7</sup>	10	5.50	..
2. 7-3':4'-trimethoxy <sup>6</sup>	20	4.50	..
3. 7: allyloxy-3':4'-dimethoxy*	20	2.07	Gelatin added
	10	4.50	do.
B. 3-Methyl Flavones			
4. 7-hydroxy	20	11.30	..
5. 7-methoxy	20	2.35	..
	10	4.21	..
6. 7-allyloxy*	20	6.50	Gelatin added
7. 7-hydroxy-8-allyl*	20	7.62	do.
8. 7-methoxy-8-allyl*	20	6.00	do.
9. 7:4'-dimethoxy*	20	2.00	do.
	10	4.77	do.
10. 7-allyloxy-4'-methoxy*	20	5.00	do.
11. 7:3':4'-trimethoxy*	20	1.47	..
	10	2.90	..
12. 7-allyloxy-3':4'-dimethoxy*	20	2.17	Gelatin added
	10	4.80	do.
C. 3-Ethyl Flavones			
13. 7-methoxy	20	6.27	..
14. 7-allyloxy*	20	..	No turning of fish in 30 min.
D. 3-Phenyl Flavones			
15. 7-hydroxy	20	30.00	..
16. 7-methoxy*	20	26.00	..
17. 7-allyloxy*	20	..	Not active
18. 7-hydroxy-8-allyl*	20	..	do.
19. 7:4'-dimethoxy*	20	..	do.
20. 5:7-dihydroxy	20	25.00	..
21. 5:7-dimethoxy	20	23.10	..
22. 5-hydroxy-7-methoxy	20	25.20	..
23. 5-hydroxy-7-allyloxy*	20	..	Not active

\* Compounds not so far reported in literature.

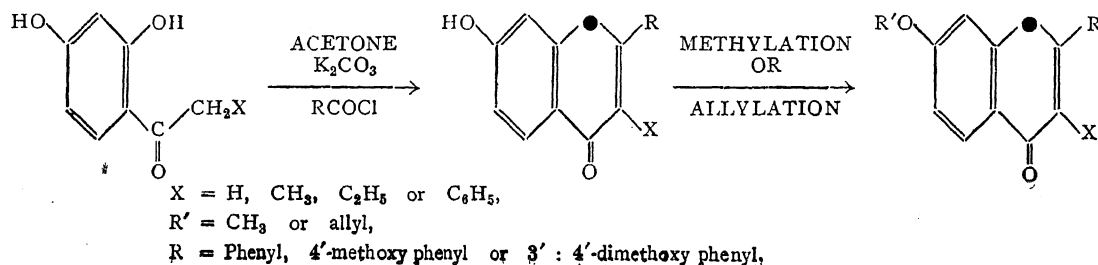


TABLE II

Compound	Concentration p.p.m.	Turning time (in minutes)	Remarks
1. Rotenone <sup>1</sup>	1	6.50	Fish did not recover
2. 7-methoxy-2-methyl isoflavone <sup>2</sup>	20	5.00	Recovered
3. 7-allyloxy-2-methyl isoflavone <sup>2</sup>	20	4.00	do.
4. 7-methoxy-8-allyl-2-methyl isoflavone <sup>2</sup>	10	4.00	do.
5. 7-dimethyl allyloxy-3':4'-dimethoxy-2-methyl isoflavone <sup>8</sup>	25	1 min. 25 sec.	..
6. 7-allyloxy-3':4'-dimethoxy-2-methyl isoflavone <sup>8</sup>	50	0 min. 58 sec.	..

These tests indicate that the introduction of a methyl group in position 3 increases the toxicity of flavone, just as substitution of a methyl group in 2 position in the case of isoflavones enhances the toxicity. The ethyl or phenyl group in position 3, however, does not seem to improve the toxicity of flavones. Methoxyl groups in 3' and 4' positions have been found to appreciably increase the activity as in the case of 7-dimethylallyloxy-2-methyl isoflavones.<sup>8</sup> Among the flavones tested, 7:3':4'-trimethoxy-3-methyl flavone is found to possess the maximum activity.

Department of Chemistry, G. SRIMANNARAYANA.  
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## SOME REACTIONS OF 2'-BENZYLOXY- CHALKONE EPOXIDES

IN our recent publication,<sup>1</sup> two polysubstituted 2'-benzyloxychalkone epoxides were found to undergo rearrangement in the presence of boron trifluoride etherate to give the corresponding  $\alpha$ -formyl deoxybenzoin which were converted into corresponding isoflavones, formononetin and  $\psi$  baptigenin. Thus a satisfactory method of synthesising isoflavones was made available following a possible mode of biogenesis. Under a different set of acidic conditions, Bogner and Stefanovsky<sup>2</sup> have observed that simple 2'-benzyloxychalkone epoxide (Ia) gave rise to dihydroflavonol (IIa). In an attempt to extend this method for the synthesis of polysubstituted dihydroflavonols, we have met with varying results and we report them briefly as follows.

Such chalkone epoxides (type 1) as have no substituents in the styryl part give good yields of dihydroflavonols when treated with ethereal hydrogen chloride under dry conditions. For example 2'-benzyloxychalkone epoxide (Ia) and 2'-benzyloxy-4'-methoxychalkone epoxide (Ib) give dihydroflavonol (IIa) and 7-methoxydihydroflavonol (IIb) respectively. Even boron trifluoride etherate gave a good yield of dihydroflavonol (IIa) in the case of (Ia) but in the case of (Ib), the dihydroflavonol (IIb) is accompanied by a larger amount of a substance which has not yet been identified. On the other hand when a methoxy group is present in the p-position of the styryl part of the chalkone epoxide (type 2) the reaction takes a different turn. Different conditions of treatment with ethereal hydrogen chloride give different products. For example 2', 4'-dibenzoyloxy-4-methoxychalkone epoxide (III) gave the chlorohydrin (IV) when dissolved in the minimum amount of ether previously saturated with dry hydrogen chloride gas and kept for a few minutes; whereas 2, 4-dibenzoyloxy phenyl-4-methoxybenzyl diketone (V) resulted when the epoxide (III) was treated with excess ethereal hydrogen chloride for a long period. In a slight modification of the latter condition, viz., passing dry hydrogen chloride gas in an ether solution of the epoxide and working up the reaction mixture after 48 hr., the reaction product was found to be a mixture of two compounds; the major one was the same diketone (V) and the minor one was 7-O-benzyl formononetin (VI). Under a still stronger acidic condition such as treatment of this

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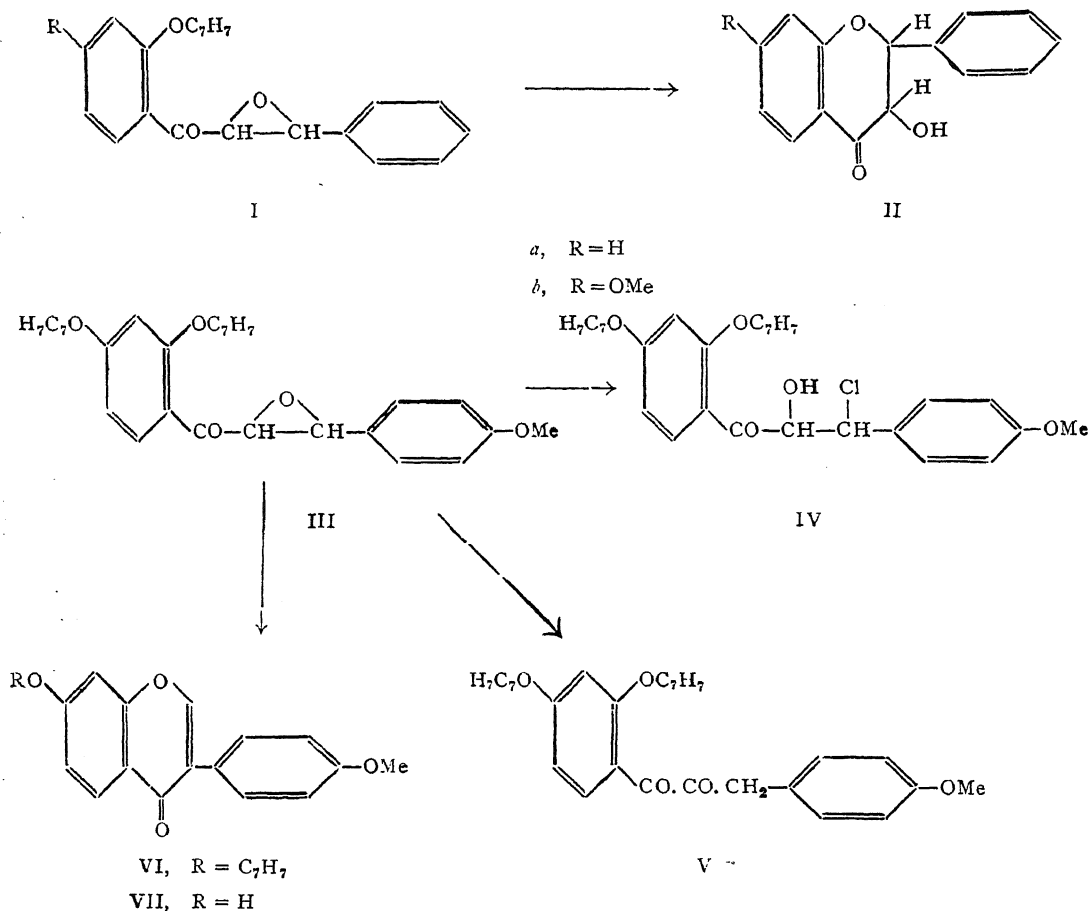
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chalkone epoxide with hydrobromic acid in acetic acid, formononetin (VII) was obtained.

do not refer to the earlier paper of Bogнар and Stefanovsky,<sup>2</sup> who reported similar results.



From the above results, it may be concluded that neither a dihydroflavonol nor an isoflavone is an exclusive product in the reactions of chalkone epoxides, even in the presence of boron trifluoride etherate; conditions of experiment and the substituents in the chalkone epoxide determine the course of the reaction. The difference in the reactions of the two types of chalkone epoxides seems to depend on the stability of the intermediate carbonium ion formed in the reaction product. The details of the reactions, characterisation of the products and a discussion of their mechanism will be the subject of the full paper, soon going to be published. This advance communication was necessitated because of a recent publication by Chopin and Durual<sup>3</sup> who have also obtained the same results with the chalkone epoxides (Ia) and (Ib); possibly by oversight they

Department of Chemistry,  
University of Delhi,  
Delhi-6, December 27, 1963.

S. C. BHRARA.  
A. C. JAIN.  
T. R. SESHADRI.

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#### PRELIMINARY STUDIES ON THE EFFECT OF MICRONUTRIENTS ON THE GERMINATION OF COCONUT SEEDNUTS

STUDIES on the effect of pretreatment of coconut seeds on germination have been initiated at this centre. In the present studies coconut seednuts of Tall variety were treated with Mg, B, Cu, Mn, Fe, Mo and Zn in two concentrations in each case, viz., MgSO<sub>4</sub>—11,500 ppm,

23,000 ppm;  $\text{Na}_2\text{B}_4\text{O}_7$ —5,750 ppm, 11,500 ppm;  $\text{CuSO}_4$ —5,500 ppm, 11,000 ppm;  $\text{MnSO}_4$ —4,250 ppm, 8,500 ppm;  $\text{FeSO}_4$ —3,750 ppm, 7,500 ppm;  $(\text{NH}_4)_2\text{MoO}_4$ —50 ppm, 100 ppm; and  $\text{ZnSO}_4$ —6,500 ppm, 13,000 ppm. The nutrients were injected into the husk of the seednuts through the tuft portion using a syringe before sowing. Each treatment was replicated six times in a randomised block design. Suitable controls were maintained.

The number of days taken for germination as well as the morphological characters were recorded. The results after statistical analysis are presented in Fig. 1.

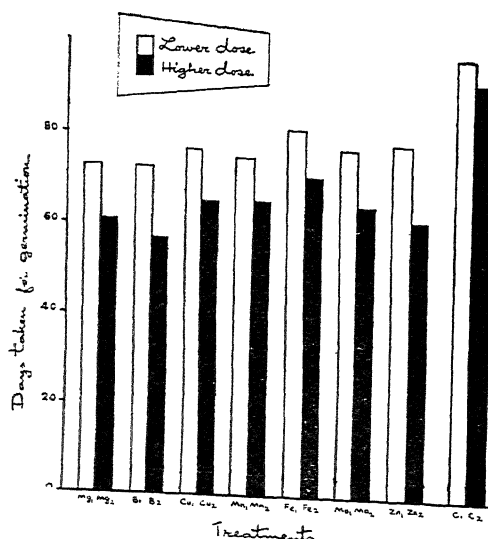


FIG. 1. Effect of micro nutrients on the germination of coconut seed nuts.

As may be noted from the figure, the period of germination is shortened by all micronutrient treatments. Significant differences have been found between the effects of B, Mg, Zn and Mo, the higher dose giving better results. It may be interesting to observe that of all the treatments, the seednuts treated with boron have germinated in 57 days. Generally, under favourable conditions, the seednuts of Tall variety germinate only 11-12 weeks after sowing.

The author is deeply indebted to Shri E. J. Verghese for suggesting this problem and supervising the work and to Dr. A. Ramadasan for his valuable suggestions.

Central Coconut Research Station,  
B. SUMATHYKUTTY AMMA.  
Kayangulam, July 19, 1963.

### AN UNUSUAL OCCURRENCE OF SULPHUR AT CHINTUR, KHAMMAM DISTRICT, ANDHRA PRADESH

THE presence of white and yellowish-white patches, stripes, and bands has been noted in a few places along the Ghat road sections of the Chintur forest. A close examination revealed these patches and bands to be sulphurous, the strong smell of sulphur also being sensed during the examination.

The sulphur occurs within a seven-mile belt between 20/4 and 6/4 furlongs, as revealed in the cuttings made for the Ghat road between Bhadrachalam and Rajahmundry (between the latitudes  $17^\circ 37'$  and  $17^\circ 42'$  and longitudes  $81^\circ 33'$  and  $81^\circ 37'$ ). The rock in which the sulphur occurs is the banded garnetiferous leptynite striking N.  $65^\circ$  E. and dipping south-east at  $65^\circ$ . The otherwise hard leptynite has been rendered gritty and friable, wherever it is impregnated with sulphur. The sulphur impregnation is inconstant, in patches, bands and streaks.

The sulphur is associated with iron sulphate (both ferrous and ferric) and a little gypsum. While the yellow colour of the patches is due to sulphur, the white colour is due to gypsum and iron sulphate, the latter constituent making up the greater proportion of the bands and patches. The iron sulphate also occurs in small pockets, as flowery concentrations, in leptynite (Fig. 1).



FIG. 1

These flowery pockets are white, yellowish-white in colour, soft, silky, capillary, concretionary and pulverulent. The white material is identified as melanterite ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ ), coquimbite [ $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ ] and copiapite [ $\text{Fe}_4(\text{OH})_2(\text{SO}_4)_5 \cdot 18\text{H}_2\text{O}$ ], melanterite being the more probable.



The source of sulphur is not traceable. Lindgren,<sup>1</sup> while giving the classification of deposits resulting from the work of underground waters, includes magnetite, serpentine, sulphur and hæmatite under those formed from abundant material contained in the surrounding rocks. Lindgren also points to the formation of native sulphur by the oxidation of pyrite resulting in crusts of sulphur-coating cavities, once occupied by the dissolved crystal. Considering the peculiar way in which sulphur occurs in this area, the source of sulphur must, however, in keeping with Lindgren's observation, be assumed to be some metallic sulphide, either pyrite or chalcopyrite, though the leptynite, as such, is not pyritiferous. The occurrence of an azure blue copper mineral, in traces, at the bed of the Sokuleru river near 20/4 furlong stone lends support to this assumption. The other reasonable assumption is that the rock containing these metallic sulphides must lie a little deeper and that the hydrothermal alteration of these sulphides must have yielded the sulphur. The hydrothermal solutions have carried the sulphur, so formed by its own activity, and redeposited it along the pores, cavities and cracks in the leptynite. Sales and Meyer<sup>2</sup> speak of the sulphur carried by the hydrothermal solutions at temperatures between 200°–400°, while discussing the sulphur deposits of Butte, Montana.

The processes, involved in the formation of sulphur, would include the oxidation of pyrite, by the oxygenated waters, to ferric sulphate and the interaction of the latter with pyrite to produce ferrous sulphate and sulphur. In the intermediate stages of the above processes, hydrogen sulphide is also produced, contributing to the formation of sulphur (Lindgren, 1933).

The ferric and ferrous sulphates formed in this process have been deposited, along with sulphur, as various sulphate minerals, as already indicated, viz., melanterite, coquimbite and copiapite. The role played by water in the evolution of sulphur is also significant. The other evidence for the part played by hydrothermal solutions in the deposition of the sulphur is the kaolinization of the leptynite rendering the rock gritty and the frequent association of the gritty matter with the sulphur.

Samples of rock taken at random indicated the percentage of sulphur from 1 to 2. Further investigation is in progress, in view of its occurrence in a wide belt, to explore the possibility of its economic exploitation.

Our thanks are due to Sri. Abdul Rahman, Divisional Engineer, Highways, Andhra Pradesh,

for drawing our attention to these deposits and to Dr. M. G. Chakrapani Naidu, Professor of Geology, for the valuable suggestions.

Dept. of Geology, K. V. SURYANARAYANA.  
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### AGE OF THE LAITRYNGEW COALFIELD, CHERRAPUNJEE

THE Laitryngew (Latitude 25° 19' 45", Longitude 91° 44' 15") Coal has tacitly been assumed to be of the same age as the Lower Cherra (Mawmluh hill: Longitude 91° 42' 0", Latitude 25° 15' 15") Coal on the basis of an apparently stratigraphical similarity. Work last field season has proved that this is not so. At both the places the coal-bearing sandstone lies over a limestone; at Mawmluh, the coal-bearing sandstone is of Lakadong age and lies over the Lakadong Limestone (basal Middle Eocene) containing such fossils as *Nummulites thalicus*, *N. sindensis*, *Lockhartia haimeii*, *Misellanea miscella*, *Discocyclus ranikotensis*.<sup>1</sup> Fossils collected from the limestone below the coal-bearing sandstone at Laitryngew have been identified by the Geological Survey of India, and they include *Cypræ* sp., *Solariella* cf. *radiatula* Forb *Exoggra* cf. *suborbiculata* Lam *Cardium* cf. *pilatum* Stol *Plicatula* sp. These indicate an Upper Cretaceous Age. In fact *Cardium* cf. *Pilatum* Stol and *Solariella radiatula* Forb have been recorded from Upper Senonian of South India.<sup>2</sup> Unfortunately the top of the coal-bearing sandstone at Laitryngew has been eroded away. The Laitryngew Coal Measures cannot be followed south to Mawmluh, due to a probable strike fault near Upper Cherra (Longitude 91° 43' 0", Latitude 25° 17' 15") which has thrown down the Measures considerably. The Coal Measures are, however, picked up south of Mawmluh in the ravine face at Mawsmi falls. We found plant-bearing carbonaceous shale immediately below the Coal Measures at Laitryngew. Two of the fossils, leaves of *Bombacites* and *Palm*, have since been generically identified by Dr. M. N. Bose of Birbal Sahni Institute of Palæobotany who assigns them to an age between Upper Cretaceous and Lower Eocene. Thus the Coal

Measures at Laitryngew belong to the same age as those of Mawberlarkar.<sup>3</sup>

We are grateful to Dr. A. G. Jhingran for having the invertebrate fossils identified at the Geological Survey of India and to Dr. Bose for the identification of the plant fossils.

Directorate of Geology and  
Mining, Assam, Shillong,  
July 31, 1963.

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K. BORDOLOI.  
B. C. BOROOAH.  
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#### AMINO-ACIDS IN URINE OF *GRYLLOTALPA AFRICANA* BEAUVOIS (ORTHOPTERA: GRYLLOIDAE)

STUDY of the free amino-acids of excreta of insects has been greatly neglected in favour of that of their hæmolymp. The only records of the amino-acid constituents of the excreta are those of *Melanoplus bivittatus*,<sup>1</sup> *Bombix mori*<sup>2</sup> and *Rhodnius prolixus*.<sup>3,4</sup> However, no study has been made of pure urine of any insect so far, probably because it is almost impossible to collect urine without being contaminated by the excreta of the insect.

In the family Gryllidae the malpighian tubules do not open directly into the gut but through a ureter, therefore pure urine, without contamination by the excreta, can be collected from the members of only this group. *Gryllotalpa africana* has been selected for the study because its hæmolymp amino-acids have already been analysed<sup>5</sup> and thus the amino-acid constituents of the two fluids can be compared.

Rakshpal<sup>6</sup> has pointed out that the ureter of *G. africana* contains colourless fluid and uratic granules. The fluid was collected from the ureter with the help of a hypodermal needle No. 18 and applied directly to the chromatographic paper Whatman No. 1 and thus the urine analysed was pure and uncontaminated. Three drops of urine could be obtained from four or five insects. No deproteinization was necessary. Desalting too was not necessary as no distortion of amino-acid position was caused by salt spots and also because only few amino-acids were present in the urine.

The chromatogram were prepared and the amino-acids were identified as described

earlier.<sup>5</sup> Single dimensional ascending chromatograms were prepared by applying three drops of urine to the same spot and placing separate spots of standard solutions of amino-acids. The solvent was allowed to run for 20 hours and the paper was sprayed with 0.2% ninhydrin in water saturated *n*-butanol.

Some seven amino-acids and amino compounds were detected in the urine of *G. africana*, they were cystine, lysine, arginine, aspartic acid, glycine, glutamic acid and an unidentified spot above glutamic acid. The degree of intensity of cystine was the lowest, and the unidentified compound was also low in concentration.

Brown<sup>1</sup> found arginine present and cystine doubtful in the excreta of *Melanoplus bivittatus*, both of them are present in the urine of *G. africana*, while cystine has been detected in the urine of *R. prolixus*<sup>4</sup> as well. Glycine is common in the excreta of *B. mori*<sup>2</sup> and in the urine of *R. prolixus*<sup>4</sup> and *G. africana*. Cystine is always present in lesser degree than the other amino-acids in all the insects studied.

Except cystine all the amino-acids detected in the urine of *G. africana* are present in its hæmolymp also; even the unidentified compound present in the two fluids occupies the same position on the chromatograms of the two fluids. The absence of the other hæmolymp amino-acids in the urine indicates that they are probably used up during metabolism. The presence of cystine in the urine and its absence in the hæmolymp is difficult to explain; however, a similar condition has been noted in *R. prolixus*<sup>7</sup> in which tryptophane is present in the excreta but is absent in the blood.

I am highly indebted to Dr. R. Rakshpal for supervising the work and for constructive criticism.

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# FUNCTIONAL MORPHOLOGY OF THE RECTAL CAECUM OF

## *NOTOPTERUS NOTOPTERUS* PALLAS

THE freshwater fish, *Notopterus notopterus* Pallas (Suborder: Notopteroidea; Family: Notopteridae), is a laterally flattened fish. According to Day (1878) it is found in fresh and brackish waters of India and Malay Archipelago. It is very commonly found in the ponds and rivers of Muzaffarnagar.

### N. NOTOPTERUS

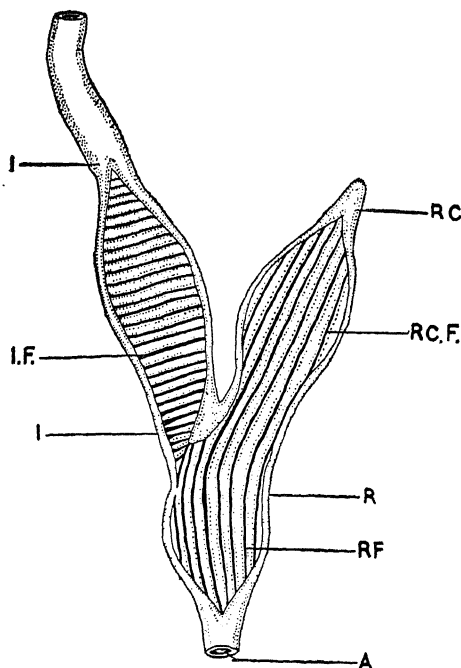


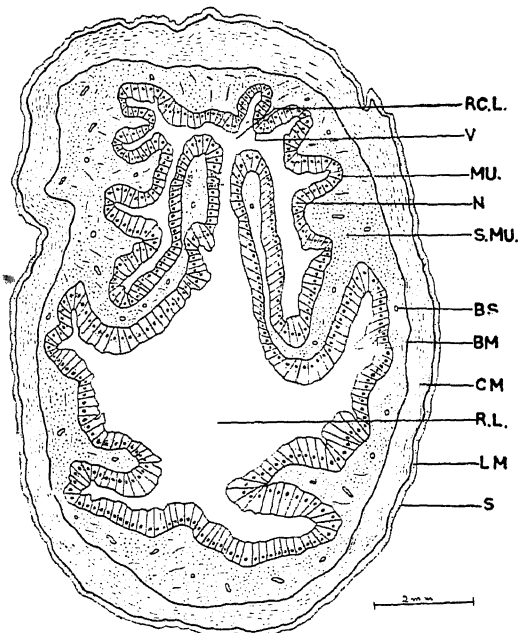
FIG. 1. *Notopterus notopterus*. A portion of the intestine, rectum and rectal caecum cut open to show the mucosal folds. (A, Anus; IF Intestinal folds; RF, Rectal folds; RC.F., Folds of rectal caecum.)

The fish is carnivorous in habit, feeding mainly on small worms and insect larvæ. The alimentary canal of *Notopterus* consists of the mouth, buccal cavity, oesophagus, cardiac stomach, pyloric stomach, intestine and rectum. The intestine, anteriorly at its junction with the pyloric stomach, gives out a pair of pyloric or intestinal cæca. The presence of a rectal cæcum is a rare occurrence among the teleost fishes. According to Brown (1957),<sup>1</sup> the digitiform rectal gland is characteristic of Selachians. However, a single well-developed tubular rectal

cæcum is present in *Notopterus* arising from the anterior and right margin of the rectum (Fig. 1). It runs anteriorly up to the pyloric stomach and lies to the right side of the intestine (Fig. 1, RC). As described by Dawes (1929)<sup>2</sup> and Al-Hussaini (1946),<sup>3</sup> a well-developed ilio-cæcal valve is present in *Notopterus* between the intestine and rectum, so that the communication between the intestine and rectum is provided through a small orifice while the rectal cæcum has a free communication with the rectum.

The mucous lining of rectum and its cæcum is raised into well-developed longitudinal mucosal folds (RC.F.) while those of the intestine are arranged transversally.

Histologically, the rectal cæcum consists of the innermost mucosa (Fig. 2, MU) which is pro-



### T.S. THROUGH JUNCTION OF RECTUM & R. CAECUM

FIG. 2. T.S. through junction of rectum and rectal cæcum. (BM, Basement membrane; BS, Blood space; CM, Circular muscles; LM, Longitudinal muscles; MU, Mucosa; N, Nucleus; RL, Rectal lumen; RC.L, Lumen of rectal caecum; S, Serosa; S.M.U., Sub-mucosa; V, Villi.)

duced into well-developed mucosal villi (about 0.4 mm.) lined with tall columnar cells which have clear inner surface and granular outer surface. Each cell has a large centrally placed spherical nucleus. In between these narrow cells are to be found a few scattered goblet cells. The submucosa of the cæcum consists of

the loose connective tissue with scattered nerve fibres and blood vessels.

The muscular coat of the cæcum consists of a very thin outer, longitudinal layer (Fig. 2, LM) and comparatively thick inner circular layer (CM).

An examination of the hydrogen ion concentration of the rectum and rectal cæcum indicates that the medium in both these regions is very near neutrality; the pH in the cæcum being 6.9.

A few experiments were performed with respect to the cæcal extract of *Notopterus notopterus* and it was found that no carbohydrates are secreted by the cæcal cells. Similarly, it was also found that neither proteases nor lipases are present in the extract of its rectal cæcum.

Finally, a few fishes were fed on carmine particles and a few others on iron saccharate; it was found that both these compounds pass into the lumen of the cæcum from where it is incorporated into the cæcal cells.

A similar but larger rectal cæcum has also been observed in *Notopterus chitala*. Thus, it may be concluded that the rectal cæcum is absorptive in nature; this explains the development of large mucosal folds of the cæcum. It may also be argued that the development of rectal cæcum is initiated by the presence of a very small alimentary canal which is limited to the anterior third of the body, while the posterior 2/3 of the body is modified into an effective propelling organ. The very active habit of the fish involves the requirement of more food, while the small intestine does not permit enough absorption of food which is, therefore, compensated by the development of the rectal cæcum.

Department of Zoology, V. P. AGRAWAL.

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#### SUPPLEMENTARY REPRODUCTIVES (NEOTENICS) FROM A COLONY OF *MICROCEROTERMES FLETCHERI* HOLMG. AND HOLMG. (ISOPTERA, TERMITIDAE)<sup>1</sup>

SUPPLEMENTARY reproductives (neoténics) have been recorded twice before from Indian termites. Holmgren<sup>2</sup> observed 13 female supplementary reproductives from Bombay in

a colony of *Microcerotermes heimi* Wasm. Vishnoi<sup>3</sup> collected 45 neoténic females from an underground nest of *M. beelsoni* Snyder from Delhi.

On 23-5-1961, while collecting termites at Yellapur (Karwar District, Mysore State), an underground nest of *M. fletcheri* yielded 256 neoténic forms from chambers in all parts of the nest, and a large number of eggs, young nymphs, soldiers and workers. The primary reproductives and the adult macropterous caste were unrepresented. Also of great interest was the presence in the nest of a new genus and species of a termitophilous Nicoletid<sup>4</sup> (*Thysanura*) consisting of many males and females.

In the Yellapur collection, all the supplementary reproductives were only of the brachypterous type and hence, in all probability, these had developed from nymphal stages. Holmgren<sup>2</sup> did not mention whether his collection contained both brachypterous, and apterous neoténics or only one of these. In *M. amboinensis*, Weyer<sup>5</sup> was able to show a regular series of transitional forms from apterous neoténics through shorter-winged brachypterous forms to longer-winged brachypterous neoténics. Vishnoi<sup>3</sup> reported only brachypterous neoténics in *M. beelsoni*. From the last two nymphal stages of *M. parvus*, Noirot<sup>6</sup> experimentally obtained several brachypterous neoténics.

The collections of Holmgren<sup>2</sup> and Vishnoi<sup>3</sup> consisted entirely of females. Weyer<sup>5</sup> recorded female and male neoténics in *M. amboinensis*. The Yellapur collection of 256 neoténics consisted of 213 females and 43 males. The neoténic females varied in length from about 4.5 mm. in the non-physogastric forms to 7 mm. in the extremely physogastric forms. The neoténic males had also undergone a limited physogastry; they varied in length from 4.2 mm. in the non-physogastric forms to 5.3 mm. in the physogastric forms. Twenty of the neoténic females (physogastric), when kept singly in glass tubes, laid eggs for a day before dying. The mature gonads of several female and male neoténics were dissected.

The occurrence of a very large number of functional neoténics of both the sexes, and the presence of large numbers of eggs and young nymphs in the colony would suggest that the colony was, at the time of collection, headed by a large number of neoténic forms reproducing sexually. Grassé<sup>7</sup> is of the opinion that a similar case is found in many termites after the death of the primary reproductives. The

observation by Weyer<sup>5</sup> that in *M. amboinensis* two or more pairs of primary reproductives may collaborate in starting a colony (i.e., a tendency for collective reproductive activity is already seen in the primary reproductives of this species) and the conclusion drawn from the works of Holmgren<sup>2</sup> and Vishnoi<sup>3</sup> that many brachypterous female neotenes can head the colony and reproduce parthenogenetically, may lend support to the view that in the genus *Microcerotermes*, the colony may tolerate all the neotenes (that are produced) to become functional, and that, depending on the species, reproduction may be sexual or parthenogenetic. According to Plateaux-Quénu,<sup>8</sup> in the case of *Reticulitermes*, *Microcerotermes* and other genera where a large number of functional neotenes may replace the primary reproductives, the colony dies sooner or later. Was this also the fate of the Yellapur colony (of *M. fletcheri*) where the societal life of the colony was perhaps being disorganized by the presence of a large number of functional neotenes?

The author is indebted to Dr. M. L. Roonwal, Director, Zoological Survey of India, for kindly identifying this termite.

Department of Zoology, K. J. JOSEPH.  
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## MERMITHID INFECTIONS IN TWO NEMATOCERAN INSECTS

THIS note reports natural infection by Mermithid worms belonging to *Mermis* sp. (Mermithidae, Ascaroidea, Nematoda), in two nematoceran insects collected by the sticky traps employed for routine procurement of the imagoes of soil breeding insects in Calcutta and the adjacent rural areas. While the infection is found only in one female insect belonging to *Atrichopogon* sp. (of the family Ceratopogonidae), in case of chironomid midges belonging to *Chironomus* sp. (of the family Chironomidae), entrapped together with the other insects, the same has been encountered quite frequently. Two instances of

such infections showing the worms *in vivo* are illustrated (Fig. 1).

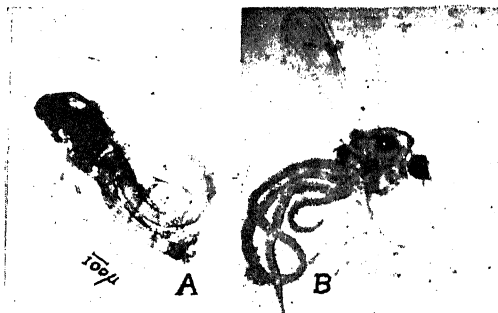


FIG. 1 (A-B). Photomicrographs showing *Mermis* worms inside *Atrichopogon* sp. (A) and *Chironomus* sp. (B).

Recently Mathur<sup>1</sup> has given an extended host list of the Mermithid worms from his own observations and combining this with the earlier records that he could trace contends that the worms mostly attack the caterpillars of Lepidoptera and, in a very small degree, those of some beetles as well as adult grasshoppers. The present records are thus additions to comparatively less known instances<sup>2-5</sup> of Mermithid infection within nematoceran insects and are of interest in being detected in the active imagoes while these are commonly met in the insect larvae which mostly succumb before reaching the adult stage as a result of emergence of the worms from their body cavity.

Thanks are due to Dr. S. Mookerjee for laboratory facilities.

Zoology Department, S. K. DAS GUPTA.  
Presidency College, Calcutta, June 28, 1963.

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## A NOTE ON THE CHEMICAL NATURE OF THE CRUSTACEAN ANDROGENIC HORMONE

THE androgenic gland of male malacostraca, which was originally discovered in *Orchestia gammarellus* by Charniaux-Cotton,<sup>1</sup> is a unique instance of an endocrine sex gland which is separate from testis. Its masculinising function is well established. It is also known that the secretion of hormone can take place without any nervous co-ordination. But the

chemical nature of hormone has not so far been determined.

The present note reports the results of some of the experiments made in our laboratory to determine the chemical nature of the androgenic hormone.

Androgenic glands from twenty mature male specimens of *Ocypoda macrocera* were removed with fine forceps. The extraction of the sterol fraction was carried out adopting the procedure described by Bergmann.<sup>2</sup> The glands were dried in a hot air oven and then extracted with petroleum ether in a soxhlet apparatus. In order to obtain the unsaponifiable material, the lipid material was refluxed with ethanolic caustic potash and cooled. The solution was then extracted with several portions of the ether. The ether extracts were combined, washed with water and evaporated on a water-bath. The residue was cooled at room temperature and tested for sterol content. Salkowsky test and Rosenheim trichloroacetic test were carried out. To crystallise the sterol the residue was extracted with several portions of methanol and evaporated on a water-bath and cooled in a desiccator for about 36 hours. Needle-shaped, elongate, colourless and waxy crystals were obtained.

The Salkowsky test gave the reverse colour reaction indicating the non-cholesterol type of sterol. Positive colour reaction was observed with Rosenheim test also. It is therefore certain that the extract is a sterol. Experiments were also carried out to test the action of the sterol. The sterol thus extracted was injected into young female crabs and found to have the same masculinising effects as are seen when androgenic gland is transplanted.

Charniaux-Cotton<sup>3</sup> has stated that the hormone secreted by the androgenic gland is not a steroid material because injections of steroids were not effective. She considers that the hormone might be a protein.<sup>3</sup> But the present author has found that the androgenic gland is not specific, the androgenic gland of one species being effective when transplanted even into a species of another genus. The experiments carried out in our laboratory show that it is not a protein but a sterol. A detailed account of the experiments will be published elsewhere.

My thanks are due to Prof. R. V. Seshaiya for suggesting the problem and guidance and to the University Grants Commission for the award of a research scholarship.

Marine Biology Laboratory, S. SAROJINI.  
Porto Novo, S. India, June 28, 1963.

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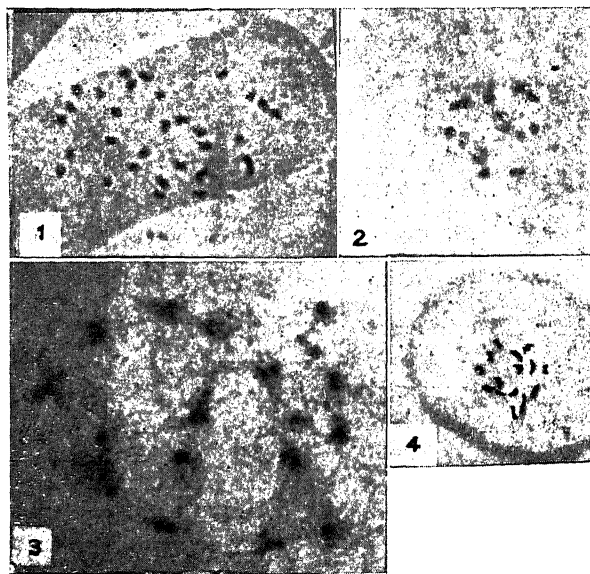
#### CHROMOSOME NUMBERS AND ABNORMALITIES OBSERVED IN A FEW MEMBERS OF ACANTHACEAE

The present note deals with the chromosome numbers and some of the meiotic abnormalities of a few species belonging to the family Acanthaceae. The species concerned are: *Cardanthera triflora* Ham., *Nelsonia campestris* Br., *Ecbolium linneanum* Kurz., and *Justicia gendarussa* Linn. growing in Calcutta and its suburbs.

The chromosome numbers which are presented in Table I are reported for the first time.

TABLE I

Name of the species	Chromosome No. (diploid)
<i>Cardanthera triflora</i> Ham.	30
<i>Nelsonia campestris</i> Br.	32
<i>Ecbolium linneanum</i> Kurz.	36
<i>Justicia gendarussa</i> , Linn.	30



FIGS 1-4. Fig. 1. Somatic chromosome in *Justicia gendarussa*. Fig. 2. Meiotic metaphase I in *Nelsonia campestris*. Fig. 3. Diakinesis in *Ecbolium linneanum*. Fig. 4. Meiotic metaphase I in *Cardanthera triflora*.

Meiosis in *Cardanthera triflora* was normal except for the late separation of two bivalents in the first anaphase. In *Nelsonia campestris* and *Ecbolium linneanum* meiosis was normal.

but the bivalents of the latter were small in size, in contrast to the large pollen mother cells. In *Justicia gendarussa*, some pollen mother cells with an acentric fragment, beside a dicentric chromatid bridge at first anaphase were observed. Laggards at first anaphase and telophase and occurrence of pentads were also observed. The pollen sterility in this species was found to vary from 40% to 55%.

I am grateful to Dr. K. T. Jacob for critically going through the manuscript.

Central Jute Agricultural Josy JOSEPH.  
Research Institute,  
Barrackpore, West Bengal, June 15, 1963.

#### A NEW SPECIES OF *PESTALOTIOPSIS* ON *ARACHIS HYPOGAEA* L. FROM BHOPAL

DURING September 1962, the plants of *Arachis hypogaea* growing in the local Nabi Bagh Farm and its adjacent fields manifested dark brown circular spots. On upper surface distinct concentric rings were visible. The diseased and healthy areas were demarcated by a yellow halo and generally they were restricted to either side of the midrib. Black spherical acervuli were prominently perceptible in the centre of the diseased regions. Isolations from the infected portions consistently yielded a species of *Pestalotiopsis* having the following morphological characters:

Mycelium light pink, septate, 3-6  $\mu$  wide, conidia ellipsoid or fusoid, mostly 4-septate (rarely two or three) with yellowish-brown central cells and hyaline apical and basal cells, average conidial length and breadth 17  $\times$  6.9  $\mu$ ; dimension of the coloured portion is variable (in 2-septate conidia 5-6  $\times$  4-5  $\mu$ ; in 3-4-septate conidia 9-14  $\times$  4-6  $\mu$ ; apical hyaline cell which is occasionally divided into two bears 1-5 (commonly 2-3) branched or unbranched slender setulae (vide Fig. 1); approximately 25% setulae are branched.

No species of *Pestalotiopsis* is so far known to exhibit such pronounced variations in the structure of the setulae. The herbarium specimen was sent to C.M.I., Kew, and Dr. Sutton of that Institute has expressed the opinion that the species is quite aberrant. The isolate is, therefore, being designated as a new species, viz., *Pestalotiopsis arachidis* Satya, Sp. Nov.

Mycelium pallide roseum, septatum, 3-6  $\mu$  latum; conidia ellipsoidea vel fusioidea, vulgo 4-septata (rarius bis terve tantum), cellulis

centralibus luteolis, cellulis apicali et basali hyalinis; longitudo et latitudo media conidorum est 17  $\times$  6.9  $\mu$ ; magnitudo partis coloratae varia (in conidiis 2-septatis 5-6  $\times$  4-5  $\mu$ ; in conidiis 3-4-septatis 9-14  $\times$  4-6  $\mu$ ; cellula apicalis hyalina, quae nonnumquam in duas est furcata, supportat 1-5 (vulgo 2-3) setulas tenues ramosas vel simplices; plus minusve 25% e setulis sunt ramosae.

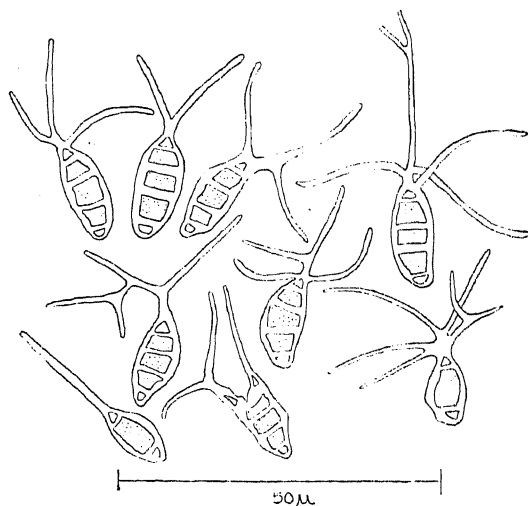


FIG. 1. *Pestalotiopsis arachidis*: Range of conidial structure.

Lectus in foliis viventibus *Arachidis hypogaeae* L. ad Bhopal, in India, mense septembri anni 1962 a Satya.

The type specimen has been deposited at C.M.I., Kew, London, as No. 96555. The author expresses his grateful thanks to Dr. R. N. Tandon, Department of Botany, University of Allahabad, for his helpful suggestions, and to Prof. O. N. Handoo for facilities and encouragement. Thanks are also due to Dr. Sutton of the C.M.I., Kew, for help in identification of the species and to Rev. Father H. Santapau for Latin diagnosis.

Pathology Section, H. N. SATYA.  
Department of Botany,  
Motilal Vigyan Mahavidyalaya,  
Bhopal, February 11, 1963.

#### PRELIMINARY OBSERVATIONS ON THE EFFECT OF DETASSELLING IN MAIZE\*

In maize pollens are given out in abundance varying in several millions by a single tassel. In such cases fertilization may not be a problem but there are possibilities that nutrition utilization by tassels may be an extra taxation on the

corn plant. Chandler (1952) reported that the nutrient absorption is maximum at early tasselling stage. As such, there are possibilities of directing the nutrition for other plant activities, if detasselling can be done without affecting the fertilization. Clarence (1956) observed that detasselling in low fertility soils had given an increase in yields.

In the study reported here the following treatments were adopted:

A. Three stages of detasselling, namely, (i) just at emergence of tassels ( $S_1$ ), (ii) one week after emergence ( $S_2$ ), and (iii) two weeks after emergence ( $S_3$ ).

B. As regards the number of rows detasselled, there were five treatments, namely, (i) no detasselling; (ii) detasselling in alternate rows; and detasselling all, leaving (iii) fifth, (iv) ninth, and (v) thirteenth rows.

A randomised block design was adopted with fifteen treatment combinations and four replications, plot size was  $15' \times 40.5'$ .

TABLE I  
Mean grain yield under different treatments

Treatments	Stages of tassel emergence			
	$S_1$	$S_2$	$S_3$	Mean
1 No detasselling	620.8	740.2	705.9	688.9
2 Alternate rows detasselled	693.9	831.5	581.6	702.3
3 Leaving every fifth row all detasselled	799.4	706.5	593.7	699.5
4 Leaving every ninth row all detasselled	699.9	618.1	502.5	607.1
5 Leaving every thirteenth row all detasselled	725.3	756.4	703.5	728.4
Mean	707.8	730.7	617.4	..
'F' test	nct			not
	signifi-			signifi-
	cant			cant
S. Em.	27.3			34.8

Grain yield data on statistical analysis did not reveal significant difference under the effects of stage of emergence, number of rows detasselled and their interactions for individual as well as pooled effects of the years. Leonard and Kiesselbach (1932) also did not observe any significant effects due to detasselling in maize on yield. However in the present study increasing trends in yields were observed when plants were detasselled just after or after a week of tassel emergence as compared to plants detasselled after two weeks of tassel emergence. Though more unfertilized space per cob (10.44) was observed when detasselled just after emergence, the higher seed index and increased yields under this stage indicate that possibly more nutrients were utilised for grain, which

otherwise might have been directed for maintenance of tassels as is apparent in case of detasseled plants at later two stages which have 8.04 and 7.00 cm. per cob unfertilized space respectively.

No definite trend was observed for the effects of number of rows detasselled on yield, thus giving an indication that detasselling could be effectively used up to 92%, i.e., in 1:12 ratio without affecting the yield. Therefore the ratio of pollen parent to seed parent could be increased from 1:3 or 4 to 1:12 without any adverse effect on the grain yield, obviously minimising the upkeep care in hybrid seed production.

Generally a cultivator has to keep watch and ward in maize fields after tassel emergence to protect the crop from birds and jackals. The same person engaged for watch and ward could be effectively utilised for carrying the detasselling operation without extra cost giving additional forage from tassels.

Thanks are due to Shri T. C. Kala and Shri M. P. Bhatnagar, who took keen interest and provided facilities during the course of this study.

Dept. of Agriculture,  
Rajasthan, Kota,  
May 17, 1963.

G. S. SHEKHAWAT.  
U. B. SINGH.  
R. K. JAIN.

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\* Contribution of the Agronomy Section, Department of Agriculture, Rajasthan.

### CHROMOSOME NUMBER IN SOME SPECIES OF COMPOSITAE

THE haploid chromosome numbers of six species of Compositae are reported in Table I. The

TABLE I

Species	Source	Haploid chromosome number
1. <i>Laggera alata</i> (Don) Sch.-Bip. ex. Oliver	Nilgiris, Madras	10
2. <i>Anaphalis adnata</i> DC.	Visakhapatnam, Andhra Pradesh	14
3. <i>A. bournei</i> Fyson	Kodaikanal, Madras	14
4. <i>A. subdecurrens</i> (DC.) Gamble	do.	14
5. <i>Achillea millefolium</i> Linn. ( <i>sensu lato</i> )	Kashmir	9
6. <i>Sonchus brachyotus</i> DC.	Howrah, W. Bengal	9



counts were made from propiono-carmines squashes of microsporocytes after fixing the flower-buds in Carnoy's fluid (9:6:1).

The chromosome number in *Laggera alata* ( $n=10$ , Fig. 1) is the same as in *L. aurita* (Mehra and Sidhu<sup>7</sup>), the only other species of the genus for which chromosome number is known. Similarly, the chromosome numbers in the three species of *Anaphalis* studied, viz., *A. adnata*, *A. bournei* and *A. subdecurrens*, all with  $n=14$  (Figs. 2-4) are in agreement with the report of Maude<sup>5,6</sup> and Sokolovskaja<sup>11</sup> for *A. margaritacea*.

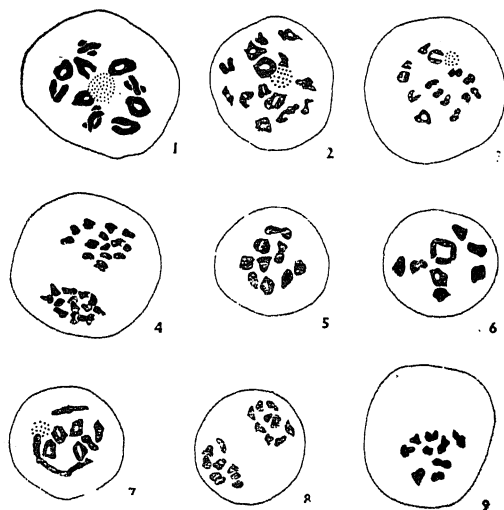
Extensive work has been carried out on the *Achillea millefolium* complex and  $2n=18$ , 36 and 54 have been reported, the somatic number in *A. millefolium* (*sensu stricto*) being 54 (see Darlington and Wylie<sup>2</sup>; Löve and Löve<sup>4</sup>). The material under investigation is a diploid with  $n=9$  (Fig. 5). Certain interesting cytological features observed in this species are briefly reported below. At diakinesis and metaphase I, in about 43% of the pollen mother cells instead of the 9 regular bivalents met with in the rest of the pollen mother cells, 7 bivalents and a ring or chain of four chromosomes were observed (Figs. 6, 7). The dis-

tribution of chromosomes at anaphase I in a few pollen mother cells examined was regular (Fig. 8). The pollen sterility, as ascertained by its stainability with propionocarmine, is 33.8%. The formation of a ring or chain of 4 chromosomes is indicative of reciprocal translocation. Moreover, as the configuration of four chromosomes is associated with the nucleolus (Fig. 7), the nucleolar chromosomes appear to be involved in the interchange.

*Sonchus brachyotus*, according to Boulos,<sup>1</sup> has been confused with *S. arvensis* and in many works considered as a synonym of the latter species. Furthermore, he states that *S. arvensis* does not occur in East Asia and the herbarium material collected from "Altaic Siberia, Mongolia, China, Japan, Formosa, Indonesia, India and Pakistan, identified as *S. arvensis* L. .... all represented *S. brachyotus* DC." Shumovich and Montgomery<sup>10</sup> investigated *Sonchus arvensis* material from Iceland and north-eastern North America and stated that the somatic number of *S. arvensis* was 54 instead of 64 as previously reported by Wulff,<sup>12</sup> Erlandsson<sup>3</sup> and Sakisaka.<sup>8</sup> Based on the material from Coimbatore (Madras State), Shetty<sup>9</sup> reported the haploid number in *S. arvensis* to be 9. This in the light of Boulos' observations, needs correction as the material investigated was actually *S. brachyotus* and not *S. arvensis*. The present study on the material from Bengal confirms the haploid chromosome number in *S. brachyotus* to be 9 (Fig. 9).

The author is indebted to Rev. Father H. Santapau, Dr. K. Subramanyam and Dr. S. K. Mukerjee for their interest in this investigation. Grateful thanks are also due to my colleagues Shri K. Thothathri, Shri N. P. Balakrishnan, Shri B. M. Wadwa and Shri J. N. Vohra for their help in collection of material.

Central National Herbarium, B. V. SHETTY.  
Howrah, Calcutta, April 11, 1963.



FIGS. 1-9. Fig. 1. *Laggera alata*, diakinesis ( $n=10$ ). Fig. 2. *Anaphalis adnata*, diakinesis ( $n=14$ ). Fig. 3. *A. bournei*, late diakinesis ( $n=14$ ). Fig. 4. *A. subdecurrens*, anaphase I ( $n=14$ ). Fig. 5. *Achillea millefolium*, metaphase I ( $n=9$ ). Fig. 6. *A. millefolium*, metaphase I ( $7_{II} + \odot 4$ ). Fig. 7. *A. millefolium*, diakinesis ( $7_{II} + \text{chain of 4 chromosomes}$ ). Fig. 8. *A. millefolium*, anaphase I ( $n=9$ ). Fig. 9. *Sonchus brachyotus*, metaphase I ( $n=9$ ). All figures,  $\times 735$ .

tribution of chromosomes at anaphase I in a few pollen mother cells examined was regular (Fig. 8). The pollen sterility, as ascertained by

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## REVIEWS

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**Phthalocyanine Compounds.** By F. H. Moser and A. L. Thomas. (Reinhold Publishing Corporation, New York-22), 1963. Pp. xiii + 365. Price \$ 18.

This is a monograph in the real sense of being a comprehensive treatise on a single and strictly limited topic. The authors are the Director of Research and the Chief Chemical Engineer of the Standard Ultramarine and Color Company of the United States, which is one of the large producers of phthalocyanine pigments. The book is a model of scholarship; every important aspect of the subject is covered and no significant reference is omitted. A unique feature is the inclusion of extracts of original papers and patents which provide the reader with detailed and authentic information without his having to take the trouble of studying the original records.

Eight chapters deal with the history of the phthalocyanines, properties, preparation, manufacture, dyes, commercial applications, phthalocyanine-type compounds, and polymers. In addition to numerous references accompanying each chapter, Appendix I gives a list of the major references. Test procedures are described in Appendix II, and Appendix III gives the Colour Index numbers of phthalocyanine pigments and dyes, the names of manufacturers, and the trade names of the pigments. There are several firms in India now producing phthalocyanine pigments, but on a relatively small scale, and consequently the authors have not been aware of them. Although there are brief descriptions (with patent references) of the dyes obtained by chloromethylation, sulphonated cobalt phthalocyanine as a vat dye, and reactive dyes derived from cyanuric chloride and other intermediates, the commercial names of Phthalogen, Alcian, Procion, Cibacron; etc., are not mentioned.

Among the properties discussed in great detail in Chapter 2 are X-ray structure, polymorphism, electron micrographs, electronic and infra-red absorption spectra, central metal atom-ligand bonding, magnetic properties, data obtained by the use of the field electron microscope, behaviour on oxidation and reduction, catalytic, semiconductor, photoconductor, photochemical, photosensitizer, luminescence, and fluorescence properties, behaviour on neutron

irradiation, flocculation, and solubility. Considering that the authors belong to a manufacturing firm, surprisingly full details are given of manufacturing methods including the special procedures required for producing pigments in desired physical forms. No one interested in any aspect of the phthalocyanines can afford to be without this book.

K. V.

**The Application of Mathematical Statistics to Chemical Analysis.** By V. V. Nalimov. (Addison-Wesley Pub. Co., Inc., Reading, Massachusetts, U.S.A.), 1963. Pp. ix + 294. Price Rs. 11.75.

Areas of application of mathematical statistics have increased in recent years. Originally confined to problems connected with economics and actuarial sciences the application of mathematical statistics spread to biology and agriculture, and later to almost all other branches of science and technology like medicine, machine building, instrument making, metallurgy, etc. Information theory, cybernetics, not to speak of nuclear physics and fundamental particles, are some of the latest additions to these areas. Amongst the new fields of application of mathematical statistics may also be included investigations connected with chemical analysis, especially in metallurgical investigations and chemistry of alloys.

Development of new analytical methods in chemical industry and engineering takes place considerably faster than their standardization. This leads to the fact that in every industrial laboratory metrological problems arise constantly, and their solution lies to a great extent on the application of the laws of mathematical statistics. Literature on the subject is wide and varied, and also rapidly growing. In the book under review an attempt has been made to bring together such distributed knowledge in a systematic and easily applicable manner. The original book written in Russian by V. V. Nalimov has been translated by P. Basu and edited by M. Williams.

The book does not claim to give a complete account of the ideas of modern mathematical statistics. Only those statistical methods which have found application in industrial and chemical laboratories, and reported in periodicals

have been considered. The emphasis throughout the book is on the practical application, and mathematical theory has been merely subordinated. Theorems and fundamental formulæ have been taken for granted, and practical uses to various types of problems are described with numerous examples which include numerical calculations. Users of the book are expected to have a prior knowledge of calculus up to the graduate standard and thorough acquaintance with the theory of probability.

The chapters in the book include: Random variables, Normal distribution, Poisson's and binomial distributions, Analysis of variance, and Statistics of linear relations. The last chapter on Statistical design of experiments contains articles on sampling, randomization, documentation and punched card systems. The Appendix contains a number of useful Tables including values of important functions, and table of random numbers.

The book will serve as a useful handbook to chemical analysts working in industrial and engineering laboratories.

A. S. G.

**International Review of Tropical Medicine,**  
Vol. II. Edited by D. R. Lincicome. (Academic Press), 1963. Pp. xiv + 425. Price \$ 16.00.

The authoritative reviews presented in this volume extend from public health aspects through clinical conditions to frontiers of research with emphasis on the conditions prevailing in the tropics.

'Abnormal Hæmoglobins and Thalassemia in Asia' reviews the distribution of the abnormal variants of hæmoglobin A and F and the incidence of serious clinical states associated with an inherited abnormality of hæmoglobin synthesis in Asia.

'Porphyria' is a comprehensive review of the diseases associated with porphyrin metabolism, featuring the clinical and laboratory findings in the porphyrias and the analytical techniques for recovery, fractionation and identification of porphyrins from biological materials.

A disease, almost confined to the tropics, is the 'phagedenic ulcer' and malnutrition appears to play a dominant rôle in the incidence of this condition.

'The Exoerythrocytic Phase of Malarial Parasites' presents the recent work done in this field since 1954.

A tale retold can be doubly sweet only if embellished by those intricate touches which can come from those who have been in a position to

obtain a contemporary view of the chief events. In the 'Story of Malaria' are outlined the personalities of the great actors in the drama—Laveran, Patrick Mason, Ronald Ross, Robert Koch, Battista Grassi and other Italian scientists in a historical perspective and makes an interesting reading.

*Drug Resistance of Protozoa* deals with the problems of cross-resistance and mechanism of development of drug resistance. The survey reveals that no metabolic or enzymic alterations are seen in the resistant trypanosomes; transformation by the DNA of drug-resistant trypanosomes is possible and melaminyl arsenicals are effective drugs for trypanosome-fast trypanosomes. During mass prophylaxis of malaria, pyrimethamine resistance is not infrequently seen and drug resistance to 4-aminoquinolines has also been observed.

'Resistance to Insecticides' is a thought-provoking article. Agricultural pests of important crops and insects transmitting diseases that have become resistant are discussed in detail and a plea is made for a rational use of these powerful pesticides.

The effect of tropical environment on the kidney function and the mechanisms involved in acclimatization are the topics reviewed in 'Renal function under tropical conditions'.

Throughout the world humans infected by worms exceed two billion; of that number three parasites—ascaris, hookworm and trichiuris—account for about three-quarters of all the helminthic infections. The assessment of the handicap imposed by parasitism on nutritional state, or on the total health picture is beset with many difficulties. Nutritional deficiency stigmata and the health criteria as affected by parasitism have been discussed in the "The problem of seeking to assess the handicap imposed by parasitism on certain aspects of health".

How hormones can influence the helminthic infections is well documented in 'ACTH and cortisone in helminthic diseases'.

It would be a very short-sighted policy and impede the industrialization and raising of the living standards for generations to come, if the intimate relationship existing between water-supply and health of the population is not realised and municipal water-supplies are designed only to meet the minimum public health needs. These aspects are featured in the article 'The quantitative relationships between community water-supplies and economic development'.

M. SIRSI.

**Pogonophora.** By A. V. Ivanov. Translated from the Russian and edited by D. B. Carlisle with additional material by Eve C. Southward. (Academic Press, London), 1963. Pp. xvi + 479. Price 90 sh.

This book is the first of its kind to deal exclusively with Pogonophora, a group of invertebrates of high systematic rank in whose structure some of the essential primitive Deuterostome characters have been preserved. Till recently, this class remained a zoological curiosity and only a few zoologists knew anything about it. Now more people are interested in this group, and it is gratifying to see a work of this kind which deals with morphology, anatomy, ecology, geographical distribution, evolution and systematic position and also the detailed classification of this group. In fact, everything known till now about the class Pogonophora is analysed and summarized by Professor Ivanov. The additions by Dr. D. B. Carlisle and Dr. E. C. Southward make this book up-to-date.

The book is in two parts. Part I deals with the different systems, embryology, ecology, geographical distribution, and systematic position. There are fifteen chapters in it. The last Chapter, "Methods of Investigation", should prove helpful to those who wish to work on this group.

Part II is a systematic account of the class. The key to different orders, families and genera, is valuable.

There are 176 diagrams drawn to scale, most of them reproductions from the original drawings by Ivanov himself. In addition, there is a map giving the geographical distribution of Pogonophora and 9 tables dealing with the characteristics of the group.

Pogonophora are amongst the common animals of the ocean, especially in the coastal areas, and there is a vast field of research open to Indian Zoologists, for nothing is known of them in our seas. The book will prove a valuable guide to students of this group. Also, it should be useful as a text-book for undergraduate and graduate students.

B. R. SESHACHAR.

**Study Projects in Physical Chemistry.** By F. E. Condon. (Academic Press), 1963. Pp. xii + 203. Price \$ 4.75.

This is a very unusual volume. The author says in the Preface that it is "not a text-book; nor is it a problem book; nor is it a laboratory manual". The volume has features some of which one expects in each of these categories. If one wants to make a student to do some

thinking by himself and tackle different parts of the subject, this is a very handy volume indeed. For a good student this is in the nature of a challenge but the average or below average should steer clear as something beyond reach. Twenty-four projects divided into four parts with a sufficient number of graph sheets and a form of productions which facilitates transfer to a file is handy and implies that the volume is for the individual and not a library. While the topics are well sorted out, a number of topics which should be normally expected of a student of Physical Chemistry are not covered at all. However as an introduction and for self-study, the volume can be recommended to an advanced student.

S. V. A.

**Newer Methods of Preparative Organic Chemistry.** Edited by W. Foerst and F. K. Kirchner. (Academic Press, New York-3), 1963. Pp. xv + 425. Price \$ 14.50.

*Newer Methods of Preparative Organic Chemistry*, Volume II, edited by Wilhelm Foerst and translated by F. K. Kirchner, deals with fourteen different topics chosen in the fields of synthetic organic chemistry and biochemistry. Review in each field is thorough and up-to-date and has provided extensive reference to original literature. Inclusion of Experimental Examples at the end of each chapter giving detailed laboratory procedures makes it extremely valuable for researchers in synthetic organic chemistry, pharmaceutical chemistry, and biochemistry, particularly because these methods are often to be found scattered throughout the literature.

D. K. BANERJEE.

### Books Received

*International Series of Monographs on Pure and Applied Biology. Zoology Division (Vol. 16)—The Evolution of the Metazoa.* By J. Hadzi (Pergamon Press, Headington Hill Hall, Oxford), 1963. Pp. xii + 499. Price £ 5.00.

*Reviews of Food Technology (Vol. 4), 1962,* (Association of Food Technology, Mysore-2), 1963. Pp. xxviii + 255. Price Rs. 8-00.

*Fifty Years of Science in India—Progress of Statistics.* By P. K. Bose. (Indian Science Congress Association, Calcutta-17), 1963. Pp. 58. Price Rs. 1-75.

*Magnetism—A Treatise on Modern Theory and Materials (Vol. III).* Edited by G. T. Rado and H. Suhl. (Academic Press, New York-3), 1963. Pp. xv + 623.

*Evolutionary and Genetic Biology of Primates.* Edited by J. Buettner-Janusch. (Academic Press, Inc., New York-3), 1963. Pp. xiv + 327. Price \$ 12.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Osmania University has awarded the Ph.D. degree in Physics to Shri D. B. Sirdeshmukh for his thesis entitled "X-Ray Investigation of Thermal Expansion of Some Cubic and Non-Cubic Crystals at Elevated Temperatures".

M.S. University of Baroda has awarded the Ph.D. degree in Botany to Shri Vinod Mansukhlal Sukkawala for his thesis entitled "Medicinal Importance of the Families Ficoidæ and Primulaceæ"; Ph.D. degree in Zoology to Shri Baburao Manjunath Hegdekar for his thesis entitled "A Study on Certain Biochemical and Histophysiological Aspects of Orthopteran Fat Body"; Ph.D. degree in Biochemistry to Shri Arvind Dattatray Deodhar for his thesis entitled "Studies on Human Lactation with Particular Reference to Dietary and Milk Vitamins".

### Raptakos Medical Research Board Fellowships

The Raptakos Medical Research Board Fellowships for the year 1964 have been awarded to the following candidates for research work on subjects mentioned against their respective names: Sri. A. S. Balasubramanian, Christian Medical College Hospital, Vellore, "Biosynthesis and Metabolism of Muco-polysaccharides"; Sri. V. V. Bhat, National Chemical Laboratory, Poona-8, "Synthetic Coagulant derived from 4-Hydroxy Coumarine"; Sri. P. D. Desai, Ramnarain Ruia College, Bombay-19, "Synthetic Adrenergic Blocking Agents"; Sri. S. A. Bangalore, Indian Cancer Research Centre, Parel, Bombay-12, "Immunological Studies with Rabbit Semen and Effect of Immunization on Fertility"; Dr. Vinod Kumar Sood, All-India Institute of Medical Science, New Delhi, "The Role of Some Biologically Active Substances in Bullæ of Unknown Aetiology".

### Lady Tata Memorial Trust Scholarships

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1964-65 commencing from 1st July 1964. Applicants must be of Indian nationality and *Graduates in Medicine or Science* of a recognised university. The scholarships are tenable in India only. Applications should reach by March 15, 1964. Candidates can obtain further information from

the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

### Conference on Low and Medium Energy Nuclear Physics

The Institute of Physics and the Physical Society, 47 Belgrave Square, London S.W. 1, announces that it is arranging a Conference on "Low and Medium Energy Nuclear Physics" to be held at the University of Sussex from 9-11 September, 1964.

The main topics of the Conference will be Nuclear structure, Electromagnetic and weak interactions, Two nucleon potential and Brueckner theory, Nuclear reactions.

The above topics will be reviewed in invited papers. Short contributed papers are invited for presentation during the Conference. Three copies of abstracts of approximately 300 words should be sent before 1st June 1964 to the Conference Secretary, Dr. W. D. Hamilton, The School of Physical Sciences, The University of Sussex, Brighton, Sussex.

### Seminar on 'Salt and By-Products'

On the occasion of the celebration of the Tenth Anniversary of the establishment of the Central Salt and Marine Chemicals Research Institute, Bhavnagar (Gujarat), it is proposed to hold a two-day seminar "On Technical Problems of Salt and By-products Industry" in the Institute on the 10th and 11th April 1964.

Intending participants may send abstracts of papers by 31st January 1964 and full papers by 29th February 1964 to Dr. R. L. Datta, Assistant Director of the Institute.

### Guano-Bird Colonies Off South African Coast

In the latest report on the Biology of Guano-Producing Sea-Birds published by the Department of Commerce and Industries, Republic of South Africa, R. W. Rand gives an analysis of the size of guano-bird colonies found on islands off the South-West African Coast. The survey extends to sea-birds found on islands between Walvis Bay and the mouth of the Orange River, spread over latitudes 24° to 28° S and longitudes 14° 30' to 15° 30' E. These breeding stations are scattered close inshore within easy sailing distance of Luderitz Bay. Altogether they form the so-called "Northern Guano Islands".

Low-level aerial photographs of bird colonies, during November 1956, provide the basis of

this report. During this period there were approximately 270,000 gannets (*Morus capensis*) breeding on three islands, namely, Possession, Ichaboe and Mercury, off South-West Africa. Ichaboe had the largest population 230,000. There were an estimated 99,000 Cape penguins (*Spheniscus demersus*) on seven islands, namely, Sinclair, Plumpudding, Pomona, Halifax and the three mentioned above. Nearly 50% of the estimated population was in Possession island. There were about 1,700 Cape cormorants (*Phalacrocorax capensis*) nesting on two islands. A far greater number, however, (estimated at over 900,000) resorted to artificial platforms in the vicinity of Walvis Bay and Cape Cross.

In Ichaboe island the huge gannet colony is a spectacular feature. A permanent staff housed here collects about 2,000 tons guano each year.—(*Investigation Report No. 46*, Division of Sea Fisheries, Cape Town.)

#### Indian Programme, International Indian Ocean Expedition

*INS Kistna* and *RV Varuna* are participating in the monsoon cruising programmes. *INS Kistna* has completed six cruises so far since July 18, 1963. In these cruises nearly all the scientific disciplines mentioned in the Indian Scientific Programme (see *Curr. Sci.*, 1963, 32, 49) were covered. The cruising programme of *RV Varuna* commenced in late July 1963. The area of operation for this vessel is limited to the continental shelf between Cape Comorin in the south and Ratnagiri in the north. The stations are, however, more closely spaced and the emphasis is on intensive studies over a limited area.—(International Indian Ocean Expedition, *Newsletter*.)

#### Use of Ultrasonics in Diagnosis

Ultrasonic echo-sounding (sonar) has something to offer in the field of diagnosis, particularly in the case of large tumour masses within the abdomen. In an illustrated article Dr. Ian Donald, Regius Professor of Midwifery, University of Glasgow, discusses the possible uses of sonar technique in the differential diagnosis of abdominal swellings.

The two-dimensional ultrasonograms are obtained by photographing the cathode-ray tube face on which the echoes are displayed. They differ, often characteristically, according to the configuration of the mass, its density, the presence or absence of fluid, and its relationship to gas-containing structures such as bowel.

The study programme which extends over many hundreds of cases; predominantly gynæ-

cological and obstetrical, is enabling Dr. Donald *et al.* to build up a library of characteristic diagnostic appearances.—(*Brit. Med. Journal*, November 9, 1963.).

#### Production of a New Anti-Particle

A team of Yale University and Brookhaven National Laboratory physicists has observed the production of a new anti-particle of matter, the anti-Xi-zero. Although its existence has been predicted on theoretical grounds for several years, the Yale Brookhaven experiment is the first to provide confirmation of this rare particle. This research confirms the fundamental physics theory of quantum mechanics which states that for every known elementary particle there must be an anti-particle. For this experiment, a beam of antiprotons at an energy of 3.69 Bev, produced by the AGS (Alternating Gradient Synchrotron) and separated by an arrangement of magnets and electrostatic separators, was directed into a 20-inch liquid hydrogen bubble chamber. Out of some three hundred thousand photographs of proton-antiproton interactions obtained in the bubble chamber, three events were observed in which an anti-Xi-zero was produced. Due to its lack of electrical charge, this particle does not leave a visible track in the chamber. Moreover, its immediate decay products, an anti-lambda-zero and a neutral pi-meson, are also unobservable. The subsequent decay of the anti-lambda particle, however, does leave visible tracks, and from these decay products and other phenomena, the preceding chain of events can be deduced. It can also be determined that the life-time of the anti-Xi-zero particle is about one ten billionth of a second. After this discovery, any new particles found in the future would require the start of the entirely new families of these fundamental building blocks of matter. Several such new families have already been postulated.—(*Jour. Frank. Inst.*, 1963, 276, 348.)

#### ERRATA

December 1963, page 544

Note entitled "Chemical Extractives of the Heartwood of *Shorea robusta*":

In the last two sentences of the first para on p. 545, for 'methyl acetate' and 'acetic acid' read 'methyl asiaticate' and 'asiatic acid'.

In the Author Index for 1963, the names of J. Venkateswarlu and V. Venkateswarlu have been clubbed. This should be read as: Venkateswarlu, J., 9, 345, 443, 514 and Venkateswarlu, V., 544.

## FLUCTUATIONS OF LUMINOSITY IN VISUAL FIELDS

SIR C. V. RAMAN

THE phenomena briefly described and commented on in the present communication are obviously of fundamental interest and offer a promising field for further investigation. It appears desirable to mention the actual circumstances in which they first came under the author's notice.

The early hours of the morning in a darkened bed room afford a convenient opportunity of observing how our visual perceptions of the brightness and colour of various objects are influenced by the strength of their illumination ranging from complete darkness before dawn to ordinary daylight levels after sunrise. Comfortably reclined in bed the author watched the appearance of a smoothly distempered wall about three metres away from his eyes under these conditions. The light reaching the wall was that from the southern sky falling on it through two ventilators high up near the ceiling of the room. The illumination was sensibly uniform over the area under observation. But not until some time after sunrise when all the objects in the room exhibited their normal outlines and colours, did the wall present the appearance of a uniformly illuminated surface. At all earlier stages it exhibited a fantastic play of moving light and shade, difficult to describe but which showed a progressive alteration in its character as the strength of the illumination increased from the zero level upwards. At the lowest levels of illumination, dark patches of extensive size appear to move over the wall becoming visible and then disappearing. At somewhat higher levels of illumination, the darker and brighter areas are distinctly smaller and shift about in a random fashion. At still higher levels, the wall appears to be covered by innumerable scintillations, continually varying in their positions and degrees of brightness. In the final stages,

the areas of fluctuating brightness appear to be quite small and contiguous to each other.

As the eyes of the observer had been rested in the dark for many hours before the effects described were noticed, it is evident that the phenomena reported are entirely characteristic of our visual perceptions and are not in the nature of any after-effects of earlier exposures of the eye to light. One may also rule out the possibility of attributing them to retinal "light" of purely subjective origin. This is clear from the manner in which the effects observed change with the strength of the illumination.

Essentially similar phenomena can be observed and studied under controlled conditions in a darkened room, using artificial sources of light of which the intensity can be varied over the necessary large range. For example, we may use an ordinary tungsten filament lamp with a frosted bulb as the source of light. Enclosing this in a box covered with apertures of various sizes through which the light can emerge, the intensity of the light received on an observing screen can be varied. A white reflecting screen or else a translucent plastic screen can be employed; in the latter case, the light emerging through the screen is viewed.

The explanation of the effects that naturally suggests is one which makes use of the fundamental notions of the quantum theory. Before light can be perceived by an observer, the energy of the radiation falling on the retina of his eyes has to be absorbed and passed on through the visual receptors and the optic nerves to the brain. Such absorption necessarily takes place in complete quanta, and we may reasonably assume that the visual sensations we experience would be determined, firstly by the number of radiation quanta falling on the retina in each small interval of time, secondly, by the proportion of that number that is actually

absorbed and thereby becomes available for perception, and thirdly by the extent of the region of the retina in which the visual receptors are located which actually take up a quantum of energy. The smaller the area of this region on the retina, the more highly localised would be the region on the screen on which the resulting illumination would manifest itself. Each of these factors would influence the results, and taken altogether they would determine the observed effects. The appearance of fluctuations of luminosity in the visual field may thus be regarded as a direct consequence of the energy of light consisting of discrete quanta. The weaker the illumination, the more conspicuously would the resulting fluctuations be expected to manifest themselves. The changing character of the observed fluctuations at different levels of illumination would be explicable as the result of the visual receptors which actually take up the energy not being the same both at the lower and at higher levels of illuminations and also being connected with the cerebral centres in a different manner in the two cases.

It can also be suggested with some confidence that the phenomena now under consideration stand in intimate relationship with the subject of the acuity of vision and its variations, and especially with the well-known influence on visual acuity of the

strength of illumination. Indeed, observational trials show that the fall in visual acuity with diminishing brightness of illumination appears in the same range of illumination as that in which the fluctuations in the luminosity of a uniformly lighted screen are distinctly observable. We are therefore entitled to infer that our eyes fail to perceive the details of the object viewed by them at low illuminations for the same reason that a uniformly lighted screen at such illuminations exhibits purely subjective variations of its observable luminosity.

Finally, we may remark that the effects with which we are concerned in the present communication are conspicuous at levels of illuminations much higher than those approaching the lower limit of visibility, where the notions of the quantum theory have been utilized to explain various facts of observation. It may also be remarked in this connection that the fluctuations of luminosity with which we are concerned here may be observed when the light sources are covered by various colour filters and the corresponding colours can actually be recognized on the observing screen. As is to be expected, the fluctuations of luminosity are most conspicuous with filters of low visual luminosity transmitting blue light and least conspicuous with the yellow filters which have a higher luminosity.

#### SIR C. V. RAMAN—HIS SEVENTY-FIFTH BIRTHDAY

IT is in the fitness of things that *Current Science* should refer in its pages to the completion by Sir C. V. Raman of 75 years of age. He is the President of the Current Science Association and has given whole-hearted support to its activities in different ways. The columns of *Current Science* have had the privilege of publishing numerous original contributions by him from time to time. The leading article in the present issue bears witness to the continued vigour and originality of his mind in opening new pathways of research.

The Fellows of the Indian Academy of Sciences, of which Sir C. V. Raman is the Founder-President, and several of his past students, who today hold leading scientific positions in the country, were desirous of the occasion of his seventy-fifth birthday which fell on November 7, 1963, being celebrated in a fitting manner. Sir C. V. Raman was unresponsive to these suggestions. But this did not prevent others from taking notice of the occasion. In particular, the well-known fortnightly *Bhavan's Journal*, published from



Bombay, featured the event in its issue of the 10th November 1963.

It may have been a coincidence that the 75th birthday of Professor Raman was followed shortly afterwards by the conferment on him of the Degree of Doctor of Science *honoris causa*, by the University of Delhi on the 2nd January 1964. Dr. C. D. Deshmukh, the Vice-

science. His is a name which all Indian intellectuals honour and respect. To the present generation, Prof. Raman symbolizes the spirit of dedicated pursuit of science in the face of handicaps. He is one of the finest products of scientific progress in a country which for many ages set its face against the spirit of scientific inquiry and is now struggling hard to find a



Chancellor of that University, himself a great scholar who has filled many distinguished offices in the country, made felicitous references to the life and work of Sir C. V. Raman, which we take the liberty of reproducing here *in extenso*.

"I present to you Professor Chandrasekhara Venkata Raman, Nobel Laureate, discoverer of the Raman Effect. Prof. Raman is a distinguished teacher who has initiated nearly two generations of students into the mysteries of

place in the dynamic world of modern science. By honouring him today we honour the new spirit of science which Prof. Raman imbibed as a pioneer and which he, along with others, like his distinguished colleague whom we also honour today, has transmitted to the present generation of scientists in India.

In Prof. Raman we find a remarkable blend of Eastern and Western cultural values, which has invested his life and work with a peculiar

charm and significance. He is a poet-scientist whose scientific researches were inspired by the sound of Indian musical instruments, by the opalescent blue of the sea and the sky, by the scattering of light and, latterly, by the fascinating shapes and colours of crystals and the nature and perception of what we perhaps vulgarly call colours. Primordial sense-perceptions have been his concern, but what limitless vistas of scientific speculation have his researches opened up to the world of science! How painstaking and far-reaching have been his great discoveries! The sense of wonder, which once produced the lofty evocations of the human spirit reflected in the *Vedas* or the *Upanishads*, has inspired Prof. Raman's great scientific adventures. Raman has the sense of dedication of the ancient Indian seers, combined with the restless spirit of scientific enquiry which is the hallmark of Western Science. This rare combination is, at once the despair and envy of his much younger colleagues. Prof. Raman has built the bridge between the visible and the invisible. Has he not proved by the use of experimental techniques how the rotation and vibration spectra of the molecule, which

reveal its structure, often lie in the distant infra-red region, outside the visible spectrum? Yet, has he not forced the normally invisible spectral lines to appear in the visible region in the Raman spectrum of molecule?

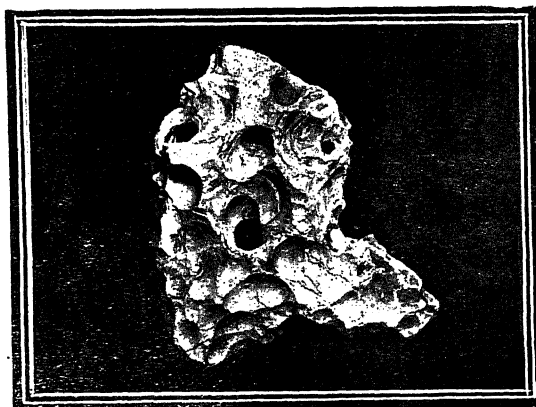
Prof. Raman has won many laurels for his great achievements which span almost half a century. He had been in the Indian Audit and Accounts Service before he was elected to be Professor at the behest of a far-sighted Vice-Chancellor who offered him a newly-created Chair of Physics, when he was only 29, in the full conviction that Raman had in him the making of a great teacher and a scientist. He is our first National Professor. We are proud to have this opportunity of honouring the best treasure that a University can possess—a great and veteran teacher who represents in his life and work the highest intellectual tradition of a University. We are indeed grateful to him for giving us an occasion to honour him.

Sir, I pray that you may be pleased to confer upon Professor Chandrasekhara Venkata Raman the Degree of Doctor of Science (D.Sc.) *honoris causa*."

### NATURE'S HANDIWORK

IN the Deccan trap areas, a walk over the countryside in unfrequented areas will enable numerous specimens of agate to be

quartz. A remarkable specimen of this kind is illustrated in the accompanying figure which is a reduction to about a third of its actual size.



picked up. Occasionally, also one finds specimens of a white porcelain-like material as an encrustation covering an inner core of crystalline

The cup-shaped hollows, and the holes are noteworthy features. The lamellar structure of the material is also evident.

# CHEMISTRY OF FLOWER COLOURS\*

T. R. SESHADRI

Department of Chemistry, University of Delhi

**F**LOWERS signify beauty of form and colour and many poets have sung their glory in rapturous verse. An excellent example is that of Tennyson who addressed The Little Flower:

"I hold you here, root and all, in my hand,  
Little flower—but if I could understand  
What you are, root and all, and all in all,  
I should know what God and man is."

According to our ancient philosophy true beauty, 'Sundaram' is an attribute of God and flowers offer the best means of worshipping Him. Naturally scientists have been attracted by them from very early times. They have expressed their feelings not in poetry or formal worship, but by experimental study with a view to understand the secret and explain the beauty of flowers. However, real progress has been made only during the present century. The studies have been largely chemical; the interesting work on the genetics of flower colours has also been described as chemical experiments *in vivo*. Quite recently our President has adopted the novel method of studying the flower petals using the hand-spectrometer with great effect. One may recall that this very useful instrument has earlier been used very fruitfully by Keilin in the discovery of cytochrome which plays a vital part in biological oxidation.

Early workers in flower colours were particularly attracted by the deeply coloured red, blue and related shades. But in their efforts they were unsuccessful because when extracted with alcohol or with water the colours had a tendency to disappear. It was left to Willstätter in the second decade of this century to understand the secret that these pigments were present as salts of coloured bases and he adopted suitable methods of acid extraction and succeeded in writing the first important chapter on the chemistry of anthocyanins. He was considerably helped by earlier studies on a group of compounds called anthoxanthins. But these were valued and understood as components of vegetable dyes; by themselves they were not so prominently coloured but when treated with

basic mordants they formed deeply coloured lakes (complex salts). This explained their success as vegetable dyes. Interest in this respect was lost after the advent of synthetic dyes, but other interests have newly developed namely their physiological function and their use as drugs and as desirable anti-oxidants. They were not considered to contribute much to attractive flower colours. Usually they exist as glycosides and these are pale yellow and only in exceptional cases, they show marked colour. But their study has been of great help in following up the nature and function of those which produce marked colour. In this field, we owe a great deal to the pioneering work of A. G. Perkin. Greater contributions to the bright yellow and orange shades of flowers are made by carotenoids. However, there are others equally important. In recent years the deep colours of flowers of *Butea frondosa* (palas), *Cosmos sulphureus* and others have been found to be due to the presence of chalcones and a closely related group called aurones.

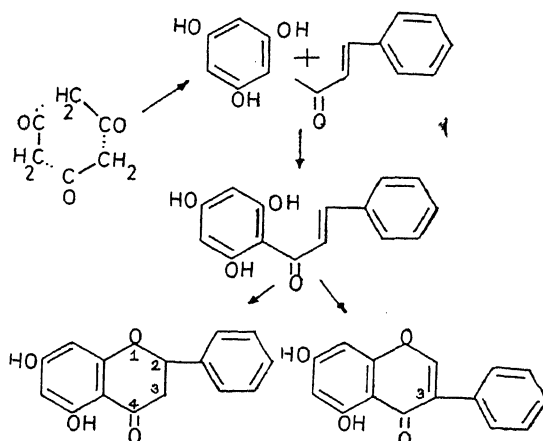


FIG. 1

Barring carotenoids which are polymers of isoprene units, the others namely anthocyanins, anthoxanthins, chalcones and aurones and a number of related compounds fall into a large group of polyphenols which is designated as 'flavonoids'. They all have the 15 carbon skeleton which is made up of two distinct parts  $C_6$  and  $C_9$ . These parts were originally con-

\* Address at the Scientific Session of the Annual Meeting of the Indian Academy of Sciences held at Nagpur on December 20, 1963.

sidered to be derived directly from sugars, but recent studies using tracer technique have established that the former is built up of 3 acetate units and the latter is derived from cinnamic acid or its equivalents. The enormous number of compounds that constitute flavonoids arise from the readiness with which new phenolic hydroxyl groups can be introduced by oxidation (nuclear oxidation) or the existing ones removed by reduction (nuclear reduction) and from other modifications such as O-methylation and C-methylation, formation of O-glycosides and of C-glycosides.

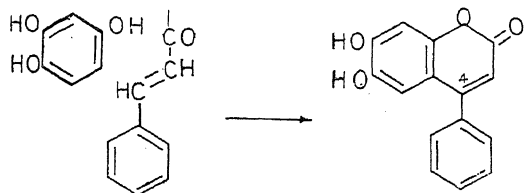


FIG. 2

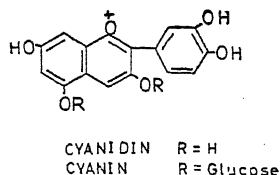
The normal flavonoids with the side phenyl in the 2-position are the most common. But a fair number of compounds called isoflavonoids have the phenyl in the 3-position; they have been shown to arise by the migration of the phenyl group at the chalcone stage. More recent studies particularly of heartwoods have brought out the existence of a new pattern of structures having the phenyl group in the 4-position. The simplest member is dalbergin obtained from the heartwood of *Dalbergia sissoo* and similar compounds are found in other Dalbergias, e.g., *D. latifolia*. This group is therefore named as 'dalberginoids' and it seems to arise by an alternative combination of the  $C_6$  and  $C_6$  units.

Attempts have been made to trace the sequence in which the different groups of flavonoids are evolved. I and my collaborators have been doing this by making a detailed survey of natural products and studying their associations in plants. Others have been using tracer technique in typical cases. The results have been discussed in recent publications. Chalcone appears to be the earliest stage and this is followed by flavanone and 3-hydroxy flavanone which represents an important intermediate because from it can be obtained flavone, flavanol, leucoanthocyanidin and anthocyanidin.

#### ANTHOCYANINS

The individual groups of compounds can now be briefly dealt with using typical

examples and their contribution to visible colour described. As already mentioned the most important are the anthocyanins which are responsible for the bright red, blue and intermediate shades. Cyanin can be taken as the typical example, it is most widely distributed. It occurs in the red rose and also in the blue corn-flower and has consequently been studied repeatedly with reference to this remarkable colour variation based on a single pigment. Since cyanin gives red in acid pH (positive ion) and blue in alkaline pH (negative ion), the colour difference was attributed to the pH of the cell sap. As a matter of fact a whole range of colours can be obtained in buffer solutions of graded pH. This explanation has, however, been disproved, since it was found that the cell sap of flowers was almost always on the acid side and remarkably corn-flower sap was more acidic than that of the rose. In the course of this study the effect of heavy metal ions and copigments arising from the presence of other polyphenols (anthoxanthins and tannins) was noted. But none of these would account for the blue of the corn-flower in an acid sap. Robinson's earlier suggestion that in the red rose cyanin was a normal salt, whereas in the blue corn-flower, there was a complex containing cyanin as a negative ion has been supported by recent detailed work on corn-flower. The blue pigment called protocyanin could be extracted by special methods and its composition and properties studied. More commonly delphinidin glycosides are present in blue flowers and a few of them have been studied similarly. The visible spectra of the major anthocyanidins and anthocyanins are quite characteristic; they have marked absorption between 510 and 550 m $\mu$ . Glycosides have comparatively lower values, the entry of sugar groups having a hypsochromic effect.



#### PROTOCYANIN

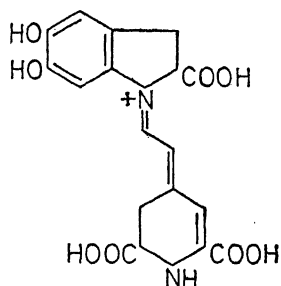
Cyanin	19.2%
$Fe^{3+}$	1 eq
$Al^{3+}$	1 eq
Carrier substance	80%

FIG. 3

There are certain orange-yellow flowers, e.g., *Gesnera fulgens* which contain a different type of anthocyanins. They lack the 3-hydroxyl group. It was originally thought that this type

is unusual. It does not seem to be so. A special characteristic of the gesneridin group is that they undergo rapid change into deeply coloured quinonoid colour bases with absorption maxima at higher wavelengths. They are more useful as dyestuffs. Actually such compounds are components of dragon blood resin, red sandal wood and of sorghum gloms.

The deep red colouring matter of the beet-root (*Beta vulgaris*) has attracted considerable interest. It has a spectrum similar to that of cyanin. It was originally considered to be a kind of anthocyanin and was given the name 'betanin'. But it is markedly unstable to acid and alkali solutions and contains nitrogen. It has therefore been called nitrogenous anthocyanin. It has been difficult to study, but by using special techniques of enzyme hydrolysis, the aglycone (betanidin) was obtained by Robinson, and he prepared, as model compounds amino derivatives of flavylum salts which resembled betanidin. But recent work, particularly using I.R. spectroscopy, has definitely shown that it belongs to a different type altogether, having indole and pyridine rings and its constitution has been formulated as shown in Fig. 4. Betanin type of pigments are found in purple *Bougainvillea* and the flowers of *Cactus* species.



Betanidin

FIG. 4

From what has been said about the beet-root it should not be thought that tubers do not have anthocyanins. A Himalayan variety of radish contains an ordinary anthocyanin. A recent interesting observation is that an Indian variety of carrot is completely devoid of carotene but contains a high percentage of anthocyanin which is a diglycoside of cyanidin. It is very attractive in appearance and is commonly used in the North for making sweets.

## FLAVONES AND FLAVONOLS

These are also called 'anthoxanthins' and occur largely as glycosides. They were earlier known as components of vegetable dyestuffs, e.g., weld and quercitron bark. They are widely distributed in various parts of plants. Quercetin is particularly valued in recent years for its medicinal property. Its glycoside, rutin, is largely extracted from buckwheat in U.S.A. and eucalyptus leaves in Australia. Rutin therapy is an established practice for diseased conditions of blood capillaries. Quercetin as its glycoside is found markedly in yellow roses and cotton flowers. Its close relation, gossypetin, is a component of many bright yellow flowers occurring in India, e.g., *Hibiscus vitifolius* and *H. esculentus*. It is more active as a drug and as an antioxidant.

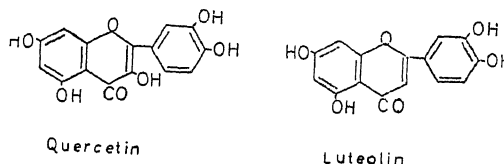


FIG. 5

## CHALKONES AND AURONES

As already mentioned, recent studies have led to the recognition of chalkones and aurones as important components of brightly coloured flowers. The case of *Butea frondosa* may be taken as a typical example. The flowers constituted a well-known vegetable dye. Perkin who studied the dried flowers found that they yielded butin which is a colourless flavanone and a small amount of butein (chalkone). These were considered to occur as glucosides. The latter workers isolated a colourless glucoside of butin called 'butrin'. It is remarkable that one of the well-known flames of the forest should yield only colourless components. The mystery was solved a few years back by investigations in Delhi. Fresh flowers were used and it was found that the major component of the flowers was a deep yellow chalkone glucoside called 'isobutrin'. When the flowers are dried this undergoes transformation into the colourless flavanone glucoside and this has been the cause of earlier misunderstanding. Isobutrin itself did not account for the whole of the colour effect. Further studies revealed the presence of a related aurone glucoside which has been named 'palasitrin'. Chalkone glycosides are found in the well-known bright yellow cosmos

flowers and also in fresh liquorice root. The structural formulæ are given in Figs. 6-7.

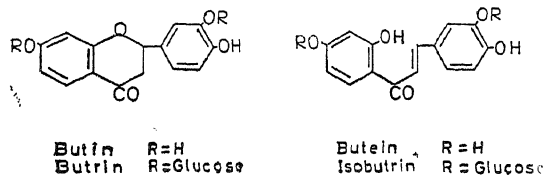


FIG. 6

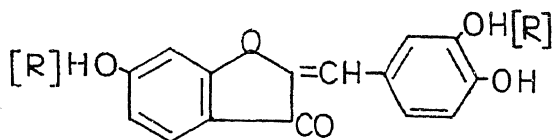


FIG. 7

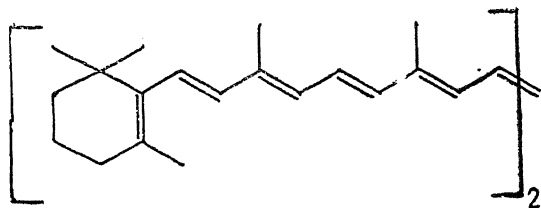
 $\beta$ -CAROTENE

FIG. 8

## CAROTENOIDS

Carotenoids are responsible for the deep yellow colours of many flowers and sometimes deeper colours are also produced by them. Carotene itself is red as a solid and so also are its concentrated solutions. Lycopene is

the cause of the deep red colour in tomatoes and crocetin of the petals of *Crocus sativa* (saffron). Bixin is present in the fruits of annatto (*Bixa orellana*) and capsanthin in red chillies. Some chillies which are purple red contain anthocyanins. The structure of the typical member  $\beta$ -carotene is given in Fig. 8.

## MISCELLANEOUS PIGMENTS

Quinones have not so far been found in flowers, but they are found in root barks, for example, Ratanjot which contains the naphthaquinone, alkannin. They are also found in woods, e.g., rosewood, *Dalbergia latifolia*. Riboflavin, which is yellow, is common in shoots and leaves and the alkaloid, berberine in roots. There is a possibility that these or related compounds can occur in flowers also though not detected so far.

## CONCLUSION

In the study of the colouring matter of flowers we have been interested in the chemical structure and the large variations it can undergo. The effect of the structural variations on spectral properties has also been followed up just as in the case of all dyes. Ordinarily emphasis has been laid on the position of absorption maximum and also of the minimum. Obviously for colour effect the behaviour in the whole spectral region counts and further the effect on the eye is most important. These subtle features have been brought out in the recent work of Professor Raman in a series of remarkable papers. A more difficult study would be the variations in the eyes of observers and I wonder if besides the visual organs the mental make-up of the individual does not play a prominent part. Music of the eyes seems to be as complex and variable in character as the music of the ears, probably it is even more complex and subtle.

# THE LOGARITHMIC ORDER OF THE PLANETS AND THEIR SATELLITES

FRANK ALLEN

University of Manitoba, Winnipeg, Canada

**S**OME law representing the order of planetary distances from the sun has been sought by astronomers, and the best that has been found is Bode's Law, which is given in Table I.

TABLE I  
Bode's law

Planet	Series	Sum ÷ 10	Solar distances Astronomical Units
Mercury ..	4+0	0.4	0.39
Venus ..	4+3	0.7	0.72
Earth ..	4+6	1.0	1.0
Mars ..	4+12	1.6	1.52
Asteroids..	4+24	2.8	2.81 Average
Jupiter ..	4+48	5.2	5.20
Saturn ..	4+96	10.0	9.54
Uranus ..	4+192	19.6	19.19
Neptune ..	4+384	38.8	30.07
Pluto ..	4+768	77.2	39.52

*Introduction to Astronomy*, Cecilia Payne-Gaposchkin, 1954, p. 176.

Astronomical Unit=Distance of the Earth from the sun 93,000 000 miles.

Though highly artificial, yet it represents quite well the order of distances, except for the planets Neptune and Pluto. Since a law of nature can have no exceptions, Bode's order cannot have the status of a law. The series in Table I, 4+3, 4+6, etc., have only an arithmetical but no astronomical significance.

In Fig. 1 the writer has plotted the order of the planets with the natural numbers from 1 to 10 as ordinates, and logarithms of their

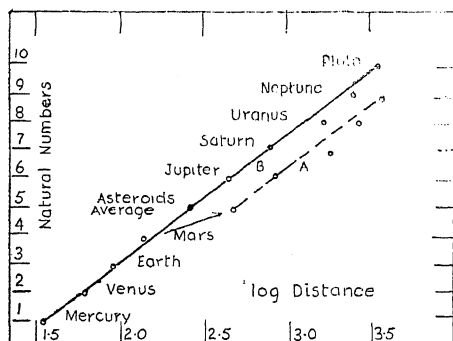


FIG. 1. The order of the planets following the natural numbers 1 to 10, with logarithms of their distances from the sun.

distances from the sun as abscissæ. This arithmetical device serves two purposes. First, it shows that by designating Jupiter as the 5th planet in the series (A), with Saturn as the 6th, etc., a break in the order of the planets occurs, which is eliminated by regarding Jupiter as the 6th planet, Saturn as the 7th, etc. This device indicates that a 5th planet is missing. Second, since the average distance of the Asteroids accurately fills the gap of the missing planet, these irregular bodies have some connection with it.<sup>1</sup> As the orbits of these 30,000, or so, fragmentary objects have no common intersection point they could not have resulted from a suggested planetary explosion; and their combined mass is much too small to constitute a new planet to fill the gap. By elevating the outer planets as (B) in Fig. 1, they follow a continuous straight line with the inner planets.

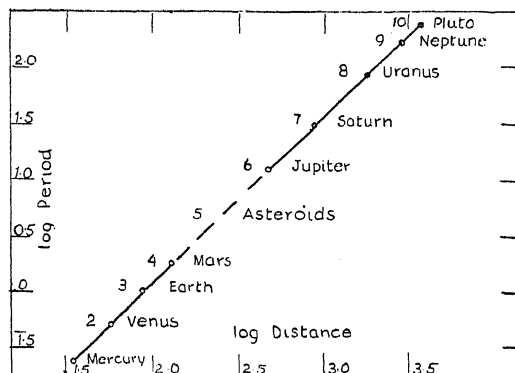


FIG. 2. The logarithmic relation of periods of revolution and distances of the planets from the sun. Replacement of Bode's Law.

In Fig. 2, logarithms of the periods of the planets, in earth-years, in their orbits around the sun, from Table II, are plotted as ordinates, and logarithms of their distances from the sun as abscissæ. The resulting graph is a straight line of which the equation is:

$$\log P = k \log D + C.$$

The constants 'k' and 'C' have astronomical significance, for 'k' is the ratio of log P to log D,

<sup>1</sup> *Introduction to Astronomy*, Cecilia Payne-Gaposchkin, 1954, p. 233.

TABLE II

Planet	Distance from Sun D	log D	Period of Rev. P	log P	Velocity in m. per sec. V	log V
Mercury ..	36	1.556	0.241	1.382	29.7	1.473
Venus ..	67	1.826	0.615	1.789	21.6	1.336
Earth ..	93	1.968	1	0	18.5	1.268
Mars ..	142	2.152	1.861	0.270	15.0	1.176
Jupiter ..	483	2.684	11.862	1.073	8.11	0.909
Saturn ..	886	2.947	29.458	1.469	6.01	0.779
Uranus ..	1783	3.251	84.065	1.924	4.22	0.626
Neptune ..	2794	3.446	164.783	2.217	3.37	0.528
Pluto ..	3670	3.565	248	2.394	2.92	0.465

	Ratio $\frac{\log V}{\log D}$	Ratio	log Ratio
Mercury ..	$\frac{1.473}{1.556}$	0.946	1.975
Venus ..	$\frac{1.336}{1.826}$	0.731	1.858
Earth ..	$\frac{1.268}{1.968}$	0.644	1.809
Mars ..	$\frac{1.176}{2.152}$	0.546	1.737
Jupiter ..	$\frac{0.909}{2.684}$	0.338	1.529
Saturn ..	$\frac{0.779}{2.947}$	0.266	1.425
Uranus ..	$\frac{0.626}{3.251}$	0.192	1.283
Neptune ..	$\frac{0.528}{3.446}$	0.153	1.185
Pluto ..	$\frac{0.465}{3.565}$	0.130	1.114

and 'C' represents the distance at which the period is zero. This logarithmic equation, since it accurately represents the relationship of the period of revolution and distance from the sun of all the planets from Mercury to Pluto, replaces the defective Bode's Law. Since the force of gravity alone governs the movements of the planets, this equation implies that gravity impresses a logarithmic relation of the period of revolution, velocity and distance from the sun of all the planets. Gravity is supreme.

In Fig. 3, from Table II, logarithms of the

velocities of the planets in their revolutions are plotted as ordinates, with, as before, logarithms of their distances from the sun as abscissæ. The resulting graph is a straight line but opposite in slope to that in Fig. 2. The same logarithmic equation applies with the difference, however, that the constant 'k' indicating the slope, is negative.

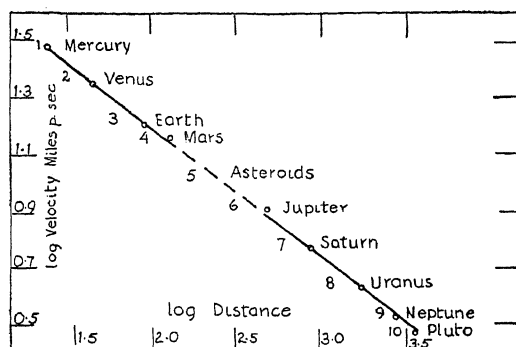


FIG. 3. The logarithmic relation of the velocities of the planets with their distances from the sun.

Since in the logarithmic equation above the constant 'k' represents the tangent of the angle of slope of the graph in Fig. 3, which involves the ratio  $\log V / \log D$ , it seemed desirable to plot the values of this ratio for all the planets. This is done in Fig. 4 in two ways as shown

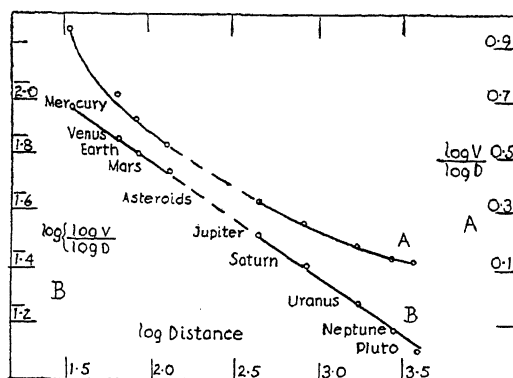


FIG. 4. Logarithmic relation of the ratios  $\log V / \log D$ .

in the figure. To the right the values of the ratios, from Table II, are plotted as ordinates with corresponding values of logarithms of the distances from the sun as abscissæ. The resulting graph, A, is a curved line. But by plotting logarithms of these ratios as ordinates, a straight line results as shown in the left of



TABLE III  
Satellites of the planet Jupiter

Distance from Planet	log D	Period Earth days	log P
(Kilometres)			
181,500	5.239	0.498	1.697
422,000	5.625	1.769	0.248
671,400	5.827	3.550	0.550
1,071,000	6.030	7.154	0.854
1,884,000	6.275	16.689	1.222
11,750,000	7.070	260.0	2.415
21,200,000	7.326	625.4	2.796
22,500,000	7.352	692.0	2.840
23,500,000	7.371	638.9	2.869
23,700,000	7.375	745.0	2.872

Introduction to Astronomy, Cecilia Payne-Gaposchkin, 1954, pp. 210, 220.

Distance from Planet-D Kilometres	log D	Period-P. Earth days	log P
Satellites of the planet Saturn			
185,700	5.269	0.942	1.974
238,200	5.377	1.370	0.137
294,800	5.469	1.888	0.276
377,700	5.577	2.736	0.437
527,500	5.722	4.517	0.655
1,223,000	6.087	15.945	1.203
1,484,000	6.171	21.276	1.328
3,563,000	6.552	79.33	1.890
12,950,000	7.112	530.44	2.725
Satellites of the planet Uranus			
130,360	5.115	1.41	0.149
191,800	5.283	2.52	0.401
267,300	5.427	4.14	0.617
438,700	5.642	8.71	0.940
586,600	5.768	13.46	1.129
Satellites of the planet Mars			
9,370	3.972	0.52	1.505
23,500	4.371	1.27	0.104
Satellites of the planet Neptune			
354,000	5.549	5.87	0.769
5,391,000	6.732	359.4	2.556

Introduction to Astronomy, Cecilia Payne-Gaposchkin, 1954, pp. 201, 220, 225, 229.

Fig. 4 by the line B. Thus logarithmic law holds for these ratios.

The movements of the numerous moons or satellites of the planets Jupiter, Saturn, Uranus and Mars conform to the same logarithmic law as the planets themselves. By plotting, from Tables III and IV, logarithms of the periods as ordinates, and logarithms of distances from the planets as abscissæ, straight lines result as shown in Fig. 5. It is quite remarkable how

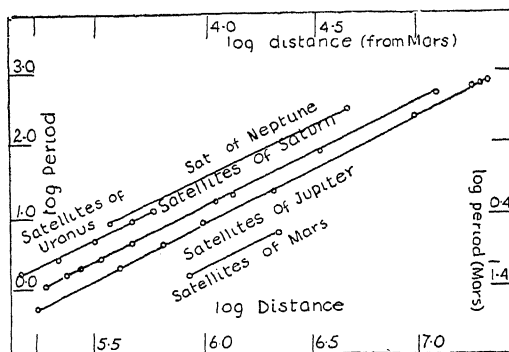


FIG. 5. Logarithmic relation of the periods and distances from the planets of the satellites of Jupiter, Saturn, Uranus, Neptune and Mars.

closely these lines are together, and how accurately they conform to the linear logarithmic law given above.

It is evident that the dominant force of gravity impresses an exact logarithmic relationship between the periods, velocities and distances from the centres of revolution of all the planets and their satellites. The force and law of gravitation imposes a logarithmic expression of the statistical order of the solar planetary system.

## SUPER-POWER MICROWAVE TUBE

A HIGHLY powerful CW Microwave tube has been introduced by Raytheon Company. The 400 lb., 6 ft. long *Super-Power Amplitron* generates 425 KW. at 72% efficiency. Delivering the highest CW. power and efficiency at 3,000 meg. (S-band), the SPA can be used to advance the output levels of conventional radars or other microwave generators in industry or medicine. Some new applications of this development are also forecast. Its high power can produce changes in plasma or bio-

logical specimens and generate free radicals. The new developmental tube employs a long-lived solid metal cathode that remains at room temperature during start-up and even under full operating conditions. Another innovation is an ogive-shaped output window permitting the tube to handle large amounts of microwave power by radiating directly into a radar antenna or other load without being limited by wave-guide considerations.—(*Jour. Frank. Inst.*, 1963, 276, 454.)

## LETTERS TO THE EDITOR

EFFECT OF DIFFUSED HYDROGEN  
ON THE KRONIG STRUCTURE  
OF THE Ni K-EDGE

THE effect of hydrogen diffusion in metals has been a subject of wide investigations. As early as 1929 Hanawalt<sup>1</sup> observed the shifts in the Kronig Structure of X-ray  $L_{III}$  absorption edge of Pd due to hydrogen diffusion. Recently Lewis<sup>2</sup> attempted to detect the changes in Ni K-edge and its fine structure due to the presence of diffused hydrogen. He diffused hydrogen by heating a Ni-foil in an atmosphere of hydrogen and could hardly observe any significant change. Recent investigations by Janko<sup>3</sup> have shown that the diffusion of hydrogen in Ni is extremely efficient if one diffuses hydrogen by making Ni as a cathode in an electrolytic cell containing acidulated water in presence of thiourea. With this method of diffusion it has been shown that Ni loses its ferromagnetic property,<sup>4</sup> the height of the hysteresis loop falls almost to zero.

The present note describes an investigation on Ni K-edge Kronig Structure in a foil in which hydrogen was introduced by the above method. It is observed that the fine structure is considerably suppressed by the presence of hydrogen and reappears after hydrogen has escaped.

A bent crystal-transmission spectrograph with 20 cm. radius was used for the investigation. A mica crystal oriented to give 100 first-order reflection was used. A Philips X-ray unit with a sealed Cu-target tube working at 18 milliamps. and 34 KV. served as a source of X-rays. Nickel foil with 2.5  $\mu$ . thickness was used. This arrangement gave Ni K-edge with fine structure in about 2 hours time.

For electrolysis a current of 0.1 amp. at 3 volts was run for about 50 hours. Since hydrogen starts escaping fifteen minutes<sup>4</sup> after switching off the current, the electrolysis was continued even after 50 hours and from the Ni foil forming the cathode, pieces were cut after every 10 minutes to be put as fresh absorber samples in the path of X-rays.

Following observations are noteworthy:

Figure 1 shows three curves. Curve (1) is the microphotometer trace of the fine structure of Ni K-edge, showing three maxima which are well known. The K-edge and the fine structure in its immediate vicinity could not be recorded

because of the overlapping of  $W L_{\alpha_{1,2}}$  lines arising out of tungsten deposit on the anti-cathode. Curve (2) shows the corresponding trace for nickel foil filled with hydrogen. Slight traces of the original three maxima appear but they are not so pronounced as indicated in Curve (1). In the dispersion used (22 x.u./mm.)

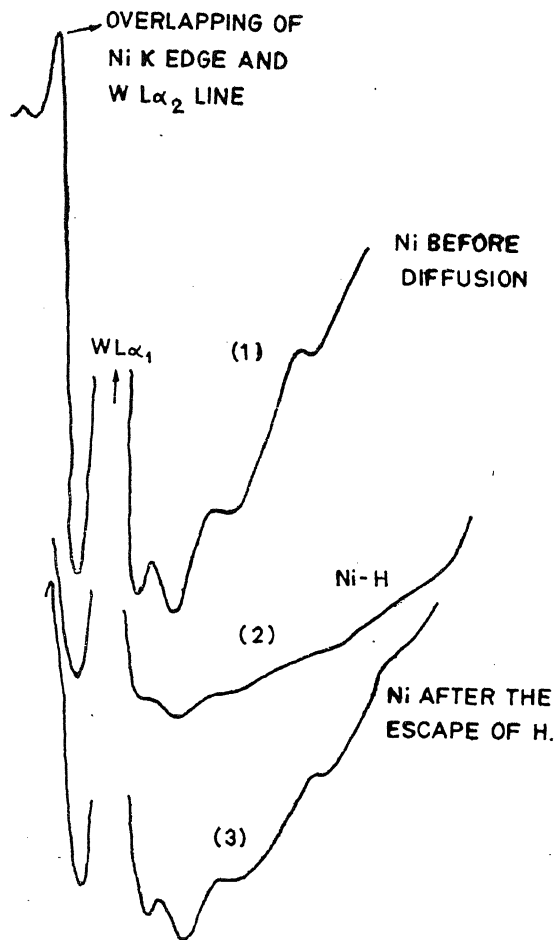


FIG. 1. Microphotometer records showing (1) the Kronig Structure in a pure nickel foil; (2) in the same foil after hydrogen was diffused and (3) in the same foil after hydrogen had escaped.

hardly any change in the position of the maxima could be measured. Curve (3) shows the spectrum of the same foil after it was left for about 4 hours. The corresponding maxima now reappear. This shows that most of the hydrogen

has escaped. Also this confirms the observations of Bauer and Schmidbauer<sup>4</sup> that it takes nearly 3 hours for a nickel foil containing hydrogen to regain completely its original ferromagnetic properties.

The author is grateful to Prof. R. K. Asundi and Dr. N. A. Narasimham, Head, Spectroscopy Division, for the encouragement given to carry out this work. Thanks are due to Dr. H. Bauer of I. Physikalisches Institut der Universität, München, for sparing some Ni-foil and to Dr. V. M. Padmanabhan for the X-ray unit.

Spectroscopy Division, AMAR NATH NIGAM.  
Atomic Energy Establishment,  
Trombay, Bombay-28, January 10, 1964.

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### RAYLEIGH SCATTERING OF 662 KeV. GAMMA-RAYS FROM DIFFERENT ELEMENTS

THE cross-section of 662 KeV. gamma-rays elastically scattered from different elements at angles ranging from 4° to 12° and 40° to 90° has been measured to investigate the 'Z' dependence of Rayleigh scattering. The method of measurement at angles greater than 40° was similar to the one used previously,<sup>1</sup> whereas at smaller angles Rayleigh cross-section was obtained by subtracting the calculated Compton

cross-section from the total measured cross-section, since at these angles Compton and Rayleigh scattering have almost the same energy and it is not possible to distinguish between them. In the angular range 15° to 30° the energy of Compton scattering is close to that of Rayleigh scattering and its intensity is about ten times the intensity of Rayleigh scattering for lead and five hundred times for aluminium. The elastic scattering is therefore masked by inelastic scattering and it is extremely difficult to determine Rayleigh cross-section with any significant accuracy. Standing and Jovanovich<sup>2</sup> have employed special techniques to isolate coherent scattering from incoherent scattering and have measured Rayleigh cross-section of 1.33 MeV. gamma-rays in this angular range for lead only.

The results are given in Tables I and II which give Rayleigh scattering cross-section for different elements and the index to the power of 'Z'. The index to the power of 'Z' at various scattering angles was determined from the slope of the cross-section vs. atomic number plot on a log-log graph. The errors in the cross-section and index to the power of 'Z' at large angles are mainly due to the uncertainties in the estimation of the contribution of incoherent scattering whereas at small angles the errors are due to statistics in counting.

The results when combined with the previous results show that when the scattering angle and therefore the momentum transfer involved in scattering process decreases, the index to the power of 'Z' decreases; this contradicts the

TABLE I

Scattering angle/ Element		Differential scattering cross-section × 10 <sup>-27</sup> cm. <sup>2</sup> per sterad				Index to the power of Z
θ°	Sn	W	Hg	Pb	n	
30±2	31±20	61±20	..	86±20		3.0±1.0
54±5	..	13.0±1.5	16.0±2.8	17.0±1.3		3.5±0.8
65±5	1.4±0.3	6.3±0.6	7.6±0.84	9.0±0.7		4.4±0.4
80±5	0.3±0.1	1.3±0.25	3.0±0.25	3.3±0.25		5.0±0.3

TABLE II

Scattering angle/ Element		Differential scattering cross-section × 10 <sup>-24</sup> cm. <sup>2</sup> per sterad				Index to the power of Z
θ°	Fe	Cu	Ag	Sn	Pb	n
4.1±0.5	1.21±0.08	1.43±0.09	4.0 ±0.2	5.0 ±0.2	19.8±0.5	2.6±0.1
5.2±0.6	0.8±0.05	1.07±0.07	2.7 ±0.12	3.3 ±0.2	12.6±0.4	2.6±0.1
6.4±0.8	0.32±0.05	0.42±0.05	1.5 ±0.1	1.7 ±0.2	7.2±0.35	2.8±0.1
7.8±1.0	0.20±0.04	0.27±0.04	1.07±0.09	1.2 ±0.15	3.9±0.4	2.7±0.1
10.2±2.0	0.22±0.04	0.29±0.04	0.55±0.06	0.55±0.08	2.0±0.16	2.7±0.1

prediction of Franz's<sup>3</sup> calculations which give  $Z^3$  dependence at all scattering angles but is in agreement with those of modified form factor.<sup>4</sup>

Physics Department,  
Panjab University,  
Chandigarh-3,  
September 30, 1963.

M. SINGH.  
S. ANAND.  
B. S. SOOD.

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### NORMAL, SIMPLE CONGRUENCES AND WEAKLY MODULAR LATTICES

THIS note deals with normal and simple elements in the lattice of congruences of a lattice. It is known that the lattice of congruences of any lattice is a complete,  $\Sigma$ -distributive lattice  $\theta(L)$  and hence is pseudo-complemented. Thus given any congruence  $\theta$  on a lattice  $L$ , we can talk of its pseudo-complement in  $\theta(L)$ . In this note we characterize the pseudo-complement of any congruence on a lattice  $L$  and establish sets of necessary and sufficient conditions for a congruence  $\theta$  on  $L$  to be (i) normal and (ii) simple. This in turn enables us to give a characterization of weakly modular lattices in terms of its congruences. By using these characterizations it can be shown that the weak modularity of  $L$  is a necessary condition for a one-one correspondence between the neutral ideals and congruences on  $L$ . Proofs of all results announced here will be appearing in a paper to be published shortly.

Next we deal with weak modularity and maximal congruences on a lattice  $L$ . Defining the weakly modular congruence  $\psi$ , on any lattice  $L$  to be that congruence generated by its ineffective intervals, we show that the intersection of all maximal congruences on any lattice  $L$  contains  $\psi$  in general and equals  $\psi$  when  $L$  is semi-discrete. As a consequence of this we arrive at a characterization of semi-discrete weakly modular lattices, viz., a semi-discrete lattice  $L$  is weakly modular if and only if the intersection of all maximal congruences on  $L$  is the null congruence on  $L$ . Next we prove that the quotient of a weakly modular lattice by a separable congruence is weakly modular. This enables us to give two characterization theorems, viz., any semi-discrete lattice is a direct union of simple

lattices if and only if it is a weakly modular lattice with permutable congruence relations; and any semi-discrete lattice is a subdirect union of simple lattices if and only if it is weakly modular.

We next prove that if the weakly modular congruence  $\psi$  on any lattice  $L$  is separable then  $L/\psi$  is weakly modular.

Yet another characterization of weak modularity is obtained in this note—we prove that any semi-discrete lattice is weakly modular if and only if the congruences generated by prime intervals of  $L$  are minimal elements of  $\theta(L)$ .

Next we show that in general the intersection of all maximal congruences on any lattice  $L$  contains the sum of all minimal non-separable congruences on  $L$  and give an example of a modular lattice with non-separable minimal congruences. Thus we have: the intersection of all maximal congruences on any modular lattice is not in general the null congruence on  $L$ .

Mathematics Dept.,  
University of Madras,  
November 4, 1963.

IQBALUNNISA.

### 3-AMINOQUINAZOLINONES AND THEIR DERIVATIVES

3, 4-DIHYDRO-3-aminoquinazolin-4-ones were prepared by refluxing a mixture of the appropriate quinazolinone and hydrazine hydrate, and removing the unreacted material by washing with alkali. Thus were obtained 3-aminoquinazolinone (m.p. 204°, reported<sup>1</sup> 203-05°), 2-methyl-3-aminoquinazolinone (m.p. 146-48°, reported<sup>2</sup> 147-48°), 2-methyl-3-amino-6-nitroquinazolinone (m.p. 221-23°, reported<sup>3</sup> 208-09°), 2-methyl-3, 6-diaminoquinazolinone (m.p. 224-26°), 2-methyl-3-amino-5-chloroquinazolinone (m.p. 156-57°), 2-methyl-3-amino-6-chloroquinazolinone (m.p. 169-71°), and 2-methyl-3-amino-7-chloroquinazolinone (m.p. 186-88°). The 3, 6-diaminoquinazolinone was also prepared by reduction of 2-methyl-3-amino-6-nitroquinazolinone with zinc and aqueous sodium hydroxide.

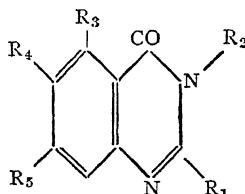
Reaction of these aminoquinazolinones with potassium cyanate and potassium thiocyanate, under acidic conditions, yielded the corresponding ureido- and thioureido-quinazolinones. Arylidene derivatives were obtained on condensing the aminoquinazolinones with aldehydes in the presence of acetic acid, pyridine or pyridine-piperidine mixture. Acylation of the aminoquinazolinones with acid anhydrides or acyl chlorides and pyridine gave the acylaminoquinazolinones,

Diazotization of 3,4-dihydro-3-aminoquinazolin-4-one, and 3,4-dihydro-2-methyl-3-aminoquinazolin-4-one with sodium nitrite and hydrochloric acid in isopropanol or in water yielded the corresponding quinazolin-4-ones.

A few typical experiments are described below.

(100 ml.; 5%). The clear brown solution thus obtained was charcoaled, filtered and acidified with acetic acid. The crude 5-chloro-2-methylquinazolin-4-one (14 g.) thus obtained was recrystallized from aqueous acetic acid; m.p. 288-90°. Found: N, 14.4; Calc. for  $C_9H_7ClN_2O$ : N, 14.4%.

Substituted Aminoquinazolinones



No.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	R <sub>5</sub>	m.p.	literature	Remarks
I	H	NHCONH <sub>2</sub>	H	H	H	219-21° d		
II	H	NHCSNH <sub>2</sub>	H	H	H	173-75° d		
III	H	NHCOCH <sub>3</sub>	H	H	H	168-70°		Shrinks at 120-25° in a sealed tube
IV	H	NHCOCH <sub>2</sub> CH <sub>3</sub>	H	H	H	104-07°		
V	H	N=CH.C <sub>6</sub> H <sub>5</sub>	H	H	H	126-28°	129° <sup>5</sup>	
VI	H	N=CH.C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	H	H	H	131-33°		
VII	H	N=CHC <sub>6</sub> H <sub>4</sub> OH (2)	H	H	H	205-07°	205° <sup>6</sup>	
VIII	H	N=CHC <sub>6</sub> H <sub>3</sub> (OH)(OCH <sub>3</sub> ) (4, 3)	H	H	H	188-91°		
IX	H	N=CH-C=CH-CH=CH-NH	H	H	H	206-08°		
X	CH <sub>3</sub>	NHCONH <sub>2</sub>	H	H	H	231-32° d		
XI	CH <sub>3</sub>	NHCSNH <sub>2</sub>	H	H	H	183-85° d		
XII	CH <sub>3</sub>	NHCOCH <sub>3</sub>	H	H	H	176°	176.5° <sup>7</sup>	
XIII	CH <sub>3</sub>	N=CH-C <sub>6</sub> H <sub>5</sub>	H	H	H	183-84°	187° <sup>4</sup>	
XIV	CH <sub>3</sub>	N=CH.C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	H	H	H	174-76°		
XV	CH <sub>3</sub>	N=CH.C <sub>6</sub> H <sub>4</sub> OH (2)	H	H	H	164-66°	171° <sup>8</sup>	
XVI	CH <sub>3</sub>	N=CHC <sub>6</sub> H <sub>3</sub> (OH)(OCH <sub>3</sub> ) (4, 3)	H	H	H	206-09°	215-16° <sup>8</sup>	
XVII	CH <sub>3</sub>	N=CH-C=CH-CH=CH-NH	H	H	H	214-16°		
XVIII	CH <sub>3</sub>	NHCONH <sub>2</sub>	Cl	H	H	215-20° d		Shrinks at 200°
XIX	CH <sub>3</sub>	NHCSNH <sub>2</sub>	Cl	H	H	182-84° d		
XX	CH <sub>3</sub>	N=CH.C <sub>6</sub> H <sub>4</sub> OH (2)	Cl	H	H	207-09°		Shrinks at 190°
XXI	CH <sub>3</sub>	NHCONH <sub>2</sub>	H	NO <sub>2</sub>	H	273-74° d		
XXII	CH <sub>3</sub>	NHCSNH <sub>2</sub>	H	NO <sub>2</sub>	H	264-66° d		
XXIII	CH <sub>3</sub>	N=CH.C <sub>6</sub> H <sub>5</sub>	H	NO <sub>2</sub>	H	173-75°		
XXIV	CH <sub>3</sub>	N=CH.C <sub>6</sub> H <sub>4</sub> OH (2)	H	NO <sub>2</sub>	H	216-18°		
XXV	CH <sub>3</sub>	NHCOCH <sub>3</sub>	H	NHCOCH <sub>3</sub>	H	254°		
XXVI	CH <sub>3</sub>	NHCONH <sub>2</sub>	H	Cl	H	234-36° d		
XXVII	CH <sub>3</sub>	NHCSNH <sub>2</sub>	H	Cl	H	191-2° d		
XXVIII	CH <sub>3</sub>	N=CHC <sub>6</sub> H <sub>4</sub> OH (2)	H	Cl	H	184-86°		
XXIX	CH <sub>3</sub>	NHCONH <sub>2</sub>	H	H	Cl	268° d		
XXX	CH <sub>3</sub>	NHCSNH <sub>2</sub>	H	H	Cl	174-76° d		
XXXI	CH <sub>3</sub>	N=CHC <sub>6</sub> H <sub>4</sub> .OH (2)	H	H	Cl	221-22°		

5-Chloro-2-methylquinazolin-4-one.—6-Chloro-N-acetyl-anthranilic acid (17 g.) and acetic anhydride (40 ml.) were refluxed for 3 hours. Excess of acetic anhydride and the acetic acid formed were distilled off *in vacuo*. The residue was allowed to react with liquor ammonia (50 ml.); the reaction mixture was boiled and rendered alkaline with sodium hydroxide solu-

5-Chloro-2-methyl-3-aminoquinazolin-4-one.—5-Chloro-2-methyl-quinazolin-4-one (4 g.) and hydrazine hydrate (15 ml.) were refluxed for 4 hours. The solid obtained on cooling was filtered and triturated with sodium hydroxide solution (50 ml.; 5%). The residue (2.7 g.) was crystallized from aqueous methanol; m.p. 156-57°. Found: N, 20.2; Calc. for  $C_9H_8ClN_3O$ : N, 20.5%.

**3-Thioureidoquinazolin-4-one.**—To a concentrated solution of 3-aminoquinazolin-4-one (4 g.) in 4 N-hydrochloric acid (10 ml.), an aqueous solution of potassium thiocyanate (4 g.) was added slowly and then the reaction mixture was kept at 60° for 30 min. 3,4-Dihydro-3-thioureidoquinazolin-4-one, which precipitated on cooling, was crystallized from aqueous alcohol, m.p. 173–75° d. Found: N, 25.2; Calc. for  $C_9H_8N_4OS$ : N, 25.4%.

**3-Ureidoquinazolin-4-one.**—It was prepared by a procedure similar to the one described for 3-thioureido-quinazolin-4-one; m.p. 219–21° d. Found: N, 26.9; Calc. for  $C_9H_8N_4O_2$ : N, 27.4%.

**3-Benzalimino-2-methylquinazolin-4-one.**—To 2-methyl-3-aminoquinazolin-4-one (1 g.) in alcohol (10 ml.) and acetic acid (0.5 ml.) was added benzaldehyde (1 g.), and the mixture refluxed for 1 hr. The pale-yellow benzalimino compound which precipitated out was crystallized from aqueous ethanol, m.p. 183–84° (reported<sup>1</sup> 187°). Found: N, 16.0;  $C_{16}H_{13}N_3O$  requires: N, 16.0%.

**Diazotization of 2-methyl-3-aminoquinazolin-4-one.**—To an ice-cold stirred suspension of 2-methyl-3-aminoquinazolin-4-one (4 g.) in water (20 ml.), isopropanol (25 ml.), and hydrochloric acid (4 ml.), a solution of sodium nitrite (2 g.) in water (8 ml.) was added dropwise. The reaction mixture was allowed to come to room temperature, and after 5 hr., the 2-methyl-quinazolin-4-one obtained was filtered and crystallized, m.p. 230–32°; hydrochloride m.p. 315–18° d; there was no depression in melting points on admixture with authentic samples.

We are deeply grateful to Prof. D. K. Banerjee, Indian Institute of Science, Bangalore, for some of the elemental analyses.

Research and Development (Miss) V. S. DIGHE.  
Division, S. SOMASEKHARA.  
Sarabhai Chemicals, G. BAGAVANT.  
Baroda, December 5, 1963. S. L. MUKHERJEE.

## AN ALKALOID COMPONENT OF *SENECIO NUDUCOILIS*

THE genus *Senecio*, family Compositae, is of special interest, since the plants belonging to it contain alkaloids which possess the characteristic property of producing liver disorders including liver tumours. Further, these alkaloids have a special structural feature and hence are called pyrrolizidine alkaloids. They do not give characteristic colour reactions by which they could be detected. They are also present in other genera of plants like *Crotalaria*, *Heliotropium*, *Trachalanthus* and *Trichodesma*. Because of their original discovery in *Senecio*, they are called *Senecio* bases.

The plants earlier attracted attention as cattle poisons producing liver disorders in grazing animals. More recently the high incidence of various liver disorders in children is being attributed to the use of herbal medicines which probably contain these alkaloids. Consequently there is considerable interest in the study of plants belonging to these genera.

*Senecio nuducoilis* is reported to grow abundantly between 5,000 and 10,000 ft. over the Himalayas and seems to have been used as a vegetable drug in rural areas. Since this plant has not been examined before and since it is fairly widespread and largely used, it has now been taken up for examination. The small amount collected in Kashmir in 1959 could be used only for a preliminary study. The sample consisted of the whole plant including roots. It gave a satisfactory test for the presence of alkaloids.

A dried sample (100 g.) of the whole plant was extracted with methanol in a soxhlet extractor. Methanol was removed under reduced pressure, the residue taken up in chloroform and the chloroform solution extracted with 1% hydrochloric acid several times. The acid extract was made alkaline with dilute ammonia and the basic component transferred to chloroform. The extract was dried over anhydrous sodium sulphate and the solvent was distilled off. The yield of the residue was 0.05%, m.p. 120–45°. On crystallisation from methanol twice, it was obtained as colourless prisms, m.p. 213–15° (d),  $[\alpha]_D^{25} -103.4$  ( $CHCl_3$ ).

The nitrate was easily obtained by treating a solution of the base in methanol with dilute nitric acid followed by addition of ether and cooling in ice. It separated as colourless needles, m.p. 205–07°. The methiodide was prepared by heating the methanolic solution with methyl iodide in a sealed tube; concentration of the solution and cooling yielded pale yellow prisms,

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m.p. 226-28° (d). The perchlorate was obtained as colourless stout prisms m.p. 240-42° (d).

The elemental analysis of the base and its salts indicate that it does not agree with any of the known *Senecio* alkaloids. Its infra-red spectrum indicates the following groups: 3650 cm.<sup>-1</sup> (OH), 1710 cm.<sup>-1</sup> (CO), 1380, 1360 and 1150 cm.<sup>-1</sup> (isopropyl). The spectrum does not show bands of good intensity in the low frequency region, which are considered characteristic for some of the *Senecio* alkaloids, viz., seneciphylline, senecionine, riddelline and retrorsine.<sup>1,2</sup> Based on the above data, the compound from *Senecio nuducoilis* is considered to be a new alkaloid; its exact nature is under investigation.

Department of Chemistry, K. AGHORAMURTI.  
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#### EFFECT OF COBALT NITRATE ON THE ISLETS CELLS AND BLOOD GLUCOSE LEVEL IN NORMAL ALBINO RATS

THE present work was taken up as there are conflicting reports in the literature regarding the effects of cobalt compounds on the blood glucose levels in (1) normal, (2) depancreatized and (3) experimentally induced hyperglycaemic animals of various species; and also on the histophysiologic changes in the islets of Langerhans.

Histological studies revealed species variations in the cytoarchitecture of pancreatic islets, e.g., in some of the species there is a preponderance of  $\beta$ -cells, in some,  $\alpha$ -cells, whereas in others there are only  $\alpha$ -cells. The maintenance of blood sugar level in these last species requires to be investigated in the light of the discovery<sup>1</sup> that  $\alpha$ -cells of the Islets are the source of glucagon, a hormone which has a hyperglycaemic action.

The role of glucagon on carbohydrate metabolism, blood sugar constancy, protein and fat metabolism and its relation to insulin and other hormones in different experimental animals have been reported.<sup>2-19</sup> Experiments using alpha-cytotoxic agents like cobalt compounds and sulphonyl urea derivatives, etc., have also been reported. Their effects were studied on the blood glucose and hepatic glycogen in normal and hyperglycaemic animals.<sup>20-25</sup>

In our experiments adult albino rats were chosen as the subjects and cobalt nitrate was used as the alpha-cytotoxic agent.

Ten adult albino rats of both sexes (weights ranging between 190 and 270 gm.) were chosen in this experiment. They were isolated from the other rats one week before the experiment and were kept on the usual laboratory diet, *ad libitum*, consisting of bengal gram, lucerne, etc. The initial blood sugar levels in all the rats were determined on fasting conditions according to Folin and Wu's photometric method, using Spectronic '20' (blood being obtained by direct puncture of the heart).

Cobalt nitrate 10 mg./kg. body weight in distilled water was given by intraperitoneal route to each of the experimental animals in the fasting state. A few of these showed signs of toxicity such as lethargy, during the first few hours, after the injection. The same daily dose of 10 mg./kg. of cobalt nitrate through the same route was repeated for 20 days. The weights of rats were taken every 7th day for 20 days. On the 21st day, final blood glucose levels were determined and the animals were sacrificed for the histopathologic examination of islets of pancreas, liver and kidneys.

In four rats blood could not be obtained on the 21st day and autopsy revealed evidence of hæmorrhage into the pericardium.

TABLE I

Rat No.	Sex	Body weight		Blood sugar level		% increase or decrease in blood sugar
		Initial gm.	Final gm.	Initial mg. %	Final mg. %	
1	F	196	197	94	78	(-16.6)
2	F	206	218	106	80	(-25)
3	F	199	207	82	80	(-2.4)
4	F	242	227	70	Blood could not be taken	
5	F	203	208	73	70	(-4.1)
6	F	235	211	89	80	(-10.1)
7	F	212	195	77	Blood could not be obtained	
8	M	230	230	83	63	(-24)
9	M	272	253	83	Blood could not be obtained	
10	M	250	242	82	do.	

From the results shown in Table I, it can be observed that cobalt compounds reduce the blood sugar level. The mechanism of action of these compounds can be assessed only after correlating the above biochemical results with those of the histophysiologic findings of  $\alpha$ -cells of the islets in the cobalt-treated animals.

Dept. of Physiology, C. SITARAMAYYA.  
Institute of Medical Sci., J. SUBBA RAO.  
Osmania Medical College, V. VIJAYA RAM RAO.  
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## DETERMINATION OF BAYTEX IN BIOLOGICAL MATERIALS

BAYTEX<sup>1</sup> (S 1752 or Bayer 29 493) which is 0, 0-dimethyl-0, 4-(methyl-thio)-3-methyl phenyl thiophosphate I is a pesticide recently synthesised and its ultra-violet and infra-red spectrophotometric studies have been reported.<sup>2</sup> Incidence of poisoning by pesticidal formulations containing Baytex has created a need for a method by which Baytex in biological materials could be determined.

In the present ultra-violet spectrophotometric and colorimetric methods, Baytex is determined as 4-(methyl-thio)-*m*-cresol II, the phenol derived by hydrolysing Baytex.

Briefly, the principal steps in the methods are (1) isolation of I by steam distillation and extraction, (2) hydrolysis of I and extraction of II and (3) chromatographic clean up and determination of II.

**Ultra-violet spectrophotometric method.**—II in 0.02 N NaOH solution is determined by the ultra-violet spectrophotometric measurement at the strong absorption peak at 259 m $\mu$ . Beer's law is followed in the range studied, viz., 0 to 55 p.p.m of Baytex.

**Colorimetric method.**—II is coupled with diazotised sulphanilic acid at pH 11.4 and the resulting azo-dye is determined at 500 m $\mu$ . Beer's law is followed in the concentration range of 0 to 50 p.p.m. of Baytex. This colorimetric method is applicable for the detection and semi-quantitative determination of Baytex at sub-microgram level on paper chromatogram.

Recovery experiments show promising results. These methods can be adapted for the routine determination of Baytex in other fields of analysis such as residue analysis.

The detailed paper will appear elsewhere.

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## ACIDS IN GARCINIA CAMBOGIA

THE dried rind of the fruit of *Garcinia cambogia* or Malabar Tamarind is used in fish preservation by the "Colombo curing" method. The organic acids present in the fruit have been held responsible for the bacteriostatic effect of the pickling medium by lowering the pH.<sup>1</sup> However, the organic acids have been mistakenly identified in the past as tartaric and citric acids.<sup>1,2</sup> Although two acid spots show up on paper chromatograms, very near to tartaric and citric acids, there is always a significant small difference in the  $R_f$ 's in all solvent systems. The acids fail to answer the cream of tartar test for tartaric acid and pentabromacetone test for citric acid. Analysis of the fruit juice by use of a formate column according to the technique of Palmer<sup>3</sup> had shown the largest peak to be in the citric region. But the fraction in this peak failed to answer tests for citric, iso-citric,



malonic and pyruvic acids, which comprise this peak (Dr. H. B. Vickery, private communication).

A close connection was found to exist between the two acid spots found on chromatograms. On saponification of the acid mixture with excess alkali and passage through a column of ion exchange resin (Zeocarb 215), the eluate showed only one spot (lower) on chromatograms. On evaporation of the eluate, more and more of the second spot (upper) started showing up, and, after complete evaporation and drying in a vacuum oven at 80° C. for 8 hours, only the upper spot was seen. The solid obtained answered characteristic tests for lactones. Thus, it is seen that the two acid spots are only that of a  $\gamma$ -hydroxy acid and its lactone and not tartaric and citric acids.

The crystalline lactone (recrystallised from ether) had m.p. 170° C. Both lactone and acid are strongly optically active; for lactone ( $\alpha$ )<sub>D</sub><sup>20</sup> = +100. From some of the data collected so far—equivalent weight 68, molecular weight about 203, basicity (by Ostwald's conductivity method), 3, we suspect the acid is dihydroxy-tricarballic acid or hydroxy citric acid. This acid has not been conclusively proved to exist naturally so far, although some claims have been made in the past.<sup>4-6</sup> In one of them,<sup>6</sup> the acid was later proved to be quinic acid.<sup>7</sup> Moreover, the amount of acid present in this fruit is to the extent of about 30% on dry solids, as compared to only traces in the materials reported earlier.

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Central Food Technological Research Institute,  
Mysore-2,  
August 16, 1963.

Y. S. LEWIS.  
S. NEELAKANTAN.  
C. ANJANAMURTHY.

*Note added to proof:* Since writing this note, the work of Griebel<sup>8,9</sup> on the presence of an (+) allo-hydroxycitric acid lactone in *Hibiscus abaoriffa* has been brought to our notice. We have now identified our acid as (–) hydroxy-citric acid, the diastereomer of hibiscus acid.

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#### OPTICALLY POSITIVE CORDIERITE FROM GAUHATI-SHILLONG ROAD, KHASI HILLS, ASSAM

CORDIERITE and sapphirine-bearing biotite granulites have been described by Ghosh (1952) and Ghosh and Saha (1954) in the gneissic complex of Nongmawait plateau in the Nongstoin State of Khasi Hills, Assam. According to Ghosh and Saha (1954), both optically positive and negative cordierite have been met with in the same section. Optically positive cordierites, though once considered somewhat rare, have been reported from several localities in and outside India in the Archæan crystalline complex. The main Indian occurrences of optically positive cordierite are from Madura (Krishnan, 1924), Travancore (Chacko, 1916), Vizagapatam (Walker and Collins, 1907; Mahadevan and Sastry, 1948), Srikakulam (Raghava Rao, 1953; Srirama Rao and Raghava Rao, 1954), and from various parts of Mysore (Radhakrishna, 1954). Specimens of cordierite biotite gneiss from Gauhati-Shillong road in Khasi hills, Assam, collected by S. Narayanaswami, Geological Survey of India, and studied by the author are found to show optically positive cordierite in association with optically negative cordierite, as recorded previously by Ghosh and Saha (1954) in the adjacent part of Nongstoin State.

The cordierite-biotite gneiss occurs as a lenticular band, about 100-200 feet wide, traversing through biotite gneiss country rock between milestones 22/4 and 22/5 on Gauhati-Shillong road. The rock is a medium-grained dark-coloured biotite-rich gneissic granulite traversed by lenticular veins of pale pink felspathic granite. The cordierite occurs as violet-blue grains ranging in size from 2 to 5 mm. Coarse aggregates of cordierite are seen at the contact of felspathic granite traversing the biotite gneiss.

Microsections of the rock reveal an irregular xenoblastic aggregate of plagioclase (andesine), microcline, quartz, cordierite, and flakes of biotite, muscovite and chlorite, together with opaques and zircon. The rough modal estimate from a few thin sections indicates about 35% cordierite, 35% plagioclase (andesine), 5% microcline, 10% quartz, 10% biotite, 3% muscovite and 2% opaques and accessories.

The optical properties of the cordierite are :

Indices	$\alpha$ 1.538 $\pm$ .002
	$\beta$ 1.543 $\pm$ .002
	$\gamma$ 1.546 $\pm$ .002
	$\gamma - \alpha$ 0.008
	2V ( $\pm$ ) 86°-88°

Determination of the optic axial angle on the Federov Stage on more than a dozen grains show that the optic sign in the majority of cases is positive, though a few sheared grains are found to be negative. Typical hexagonal twinning of cordierite is not present, but a faint lamellar twinning is seen in a few grains.

The mineral shows numerous pleochroic haloes around tiny grains of zircon, as well as the typical alteration to pinite and chlorite along cracks (Fig. 1). The pinitic alteration following radial network of cracks is a characteristic feature towards the contact of cordierite-rich layer with plagioclase-rich layer (Fig. 2).

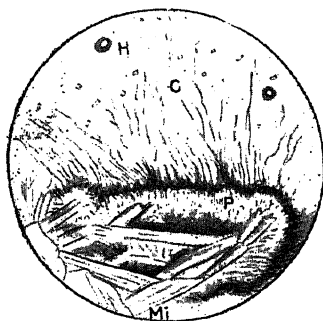


FIG. 1

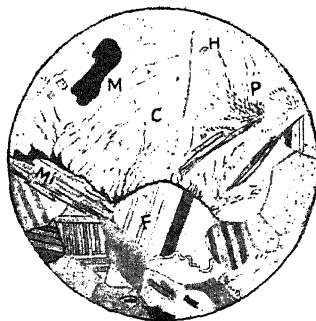


FIG. 2

C, Cordierite ;

M, Magnetite ;

F, Plagioclase ;

Mi, Mica ;

H, Pleochroic Haloe ;

P, Pinite

The variation in the optic sign of cordierite in different grains previously recorded from the cordierite-bearing granulites of Nongstoin area by Ghosh and Saha (1954) is a noteworthy feature, which has been confirmed in the present occurrence on Gauhati-Shillong road. Krishnan (1924) felt that the change in optic sign resulting in the positive optical character of cordierite was probably due to isomorphous replacement of MgO by FeO. This view, however, did not receive support from the recent study of cordierites from Vizagapatam (Mahadevan and Sastry, 1948) and Srikakulam (Srirama Rao and Raghava Rao, 1954). The presence of both optically positive and negative cordierites in the cordierite-bearing granulites and gneisses of

Khasi hills might yield a clue to the relation of the optic sign of the mineral with the chemical composition. Folinsbee (1941) observed that alkalis have a pronounced effect on the optical properties of cordierite. The segregation of cordierite in the present occurrence, along contacts of granite veins, might point to introduction of alkalis during metasomatic recrystallisation. A detailed chemical and petrological study of the cordierites from Khasi hills will help to confirm this relation and to throw further light on the problems of wide variations in the optical properties of this important rock-forming mineral.

The author is indebted to C. Karunakaran, Geological Survey of India, for pointing out to the occurrence of the mineral on Gauhati-Shillong road, and to the Director-General, Geological Survey of India, for laboratory facilities.

Shillong,

P. LAKSHMI NARAYANASWAMI.

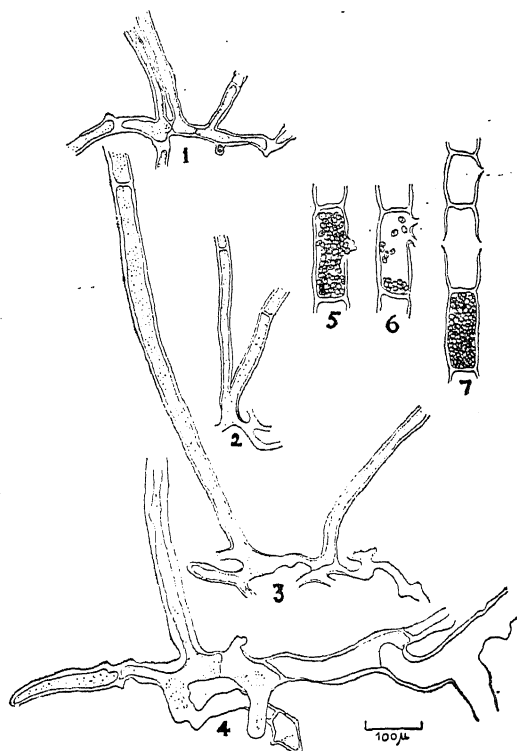
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# SOME OBSERVATIONS ON *BASICLADIA CHELONUM* (COLLINS) HOFFMANN AND TILDEN

THE genus *Basicladia* (Hoffmann and Tilden, 1930) is not uncommon on the carpace of fresh-water turtles in the American continent. The alga has also been reported from China and Japan but so far there is no record of its occurrence in India. It has recently been collected from the Water Works at Kanpur.\*

The alga grows on the side-walls and cross-bars of one of the channels. The water level in the channel rises and falls and the alga is therefore immersed or exposed at intervals. It however remains moist due to splashing of water. This shows that the significant feature here is the amphibious habit as suggested by Tilden (1935) and there is no intimate association between the alga and the freshwater turtles as is at present assumed (Tiffany, 1951). It seems a coincidence that it was so far reported on the carpace of turtles only.



FIGS. 1-4

The characteristic feature of the alga is the heterotrichous habit. A detailed examination of the material shows the presence of a distinct

and well-developed prostrate system of rhizoidal branches. These are crisp and readily break into parts during examination (Figs. 1-4). The erect filaments, 15-30  $\mu$  at the base and 40-60  $\mu$  above, originate from the prostrate rhizoidal branches and are normally unbranched or rarely forked at the base (Figs. 2-4).

Zoospore formation takes place in large numbers from ordinary vegetative cells or zoosporangia up to 60  $\mu$  broad and up to 160  $\mu$  long. These are liberated through pore or pores in the lateral wall (Figs. 5-7). Liberation of zoospores begins early in the morning and may continue till late in the afternoon.

Three species of *Basicladia* have been described, *B. crassa*, *B. chelonum* and *B. sinensis*. The form in question differs slightly from *B. chelonum* in the filaments and sporangia being slightly broader. Britton and Tiffany (1951) however recorded *B. chelonum* from Illinois, in which filaments may sometimes be up to 120  $\mu$  broad. The alga may be described as *B. chelonum*.

The alga is of interest as it is one of the few heterotrichous Cladophorales. A detailed life-history is under study.

Christ Church College,  
Kanpur, June 14, 1963.

A. B. GUPTA.  
D. N. JHA.

\* The alga forms part of a collection made during investigations on the control of algae in a Scheme of the Scientific Research Committee, U.P.

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## CHROMATOGRAPHIC DETECTION OF SOME TRACE ELEMENTS IN LEAVES OF SUNFLOWER (*HELIANTHUS* *ANNUUS*) PLANT

THE extraction and identification of trace elements from plants require a very accurate and dependable method in view of their presence in exceedingly minute quantities. One such is the paper chromatographic method, which has been widely applied in ore analysis.<sup>1</sup> The present study deals with the application of this technique to the detection of inorganic constituents in plants.

TABLE I

Sl. No.	Solvent mixture	Spraying reagent	Metallic cation	R.F. values	
				Authors	Brustall
1.	N-butanol, saturated with 3 N HCl	Dithiozone	Cu	0.2	0.2
2.	Glacial acetic acid containing 25% (V/V) of dry methyl alcohol	Alcoholic Alizarine and then exposed to ammonia vapours	Fe	0.78	0.8
			Al	0.36	0.33
3.	Acetone containing 5% of water and 8% of con. hydrochloric acid	Alcoholic Alizarine containing 0.1% of Rubeanic acid and 1% of Salicylal-doxime	Mn	0.31	0.3
			Zn	0.91	0.9

Leaves from two weeks old Sunflower (*Helianthus annuus*, Linn.) plants were collected, dried and they were ashed at 600° C. The ash was dissolved in 2N hydrochloric acid. The solution was evaporated to dryness and the residue was again treated with 5 ml. of concentrated hydrochloric acid and the final volume was made up to 25 ml. with distilled water. The resulting ash extract was subjected to chromatographic analysis for trace elements without any further treatment.

An ascending type of chromatographic technique with Whatman No. 1 filter-paper of 33 cm. square was used. 0.1% solutions of the chlorides of copper, iron, aluminium, zinc and manganese were prepared for referencing. Both the solutions, the test and the reference, were simultaneously chromatographed on the same paper. The R.F. values with different solvents were determined. The results are given in Table I along with the R.F. values by Brustall *et al.*<sup>2,3</sup>

The authors consider that the paper chromatographic technique could be used with convenience for the detection of inorganic cations in plants.

Department of Botany, P. M. SWAMY.  
Sri. Venkateswara University I. M. RAO.  
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### FRUIT ROT OF *EMBLICA* *OFFICINALIS* GAERTN. CAUSED BY *PESTALOTIA CRUENTA* SYD. IN INDIA

'ANVALA' (*Embllica officinalis* Gaertn. syn. *Phyllanthus emblica* L.) occurs throughout tropical and subtropical India. Its fruits are the richest source of vitamin C and they have tremendous medicinal values in dysentery, jaundice, dyspepsia, scurvy, anaemia and inflammation of the eye.

A fruit-rot disease of *Embllica officinalis* was observed in the local market during November 1962. Consistent isolations from the diseased fruits invariably yielded a pathogenic species of *Pestalotia*. The spots on the fruits were mostly irregular and brown in colour. The disease usually starts as a brownish discolouration on the fruit surface, which develops slowly. Later the spots become mummy brown<sup>6</sup> and the skin around them develops light brown colouration. At a relatively later stage the infected region becomes covered with white fluffy aerial growth of the fungus. The internal part of the diseased fruit shows a dry, dark brown area. Isolations from it invariably yielded a species of *Pestalotia* showing the following characters:—

Hyphae branched, septate, hyaline, 4–6  $\mu$  in thickness. Acervuli black and gregarious. Conidia fusiform, 5-celled, 16.5–24  $\times$  5.5–7  $\mu$ . Three intermediate cells coloured, versicolorous; upper two umber and lowest olivaceous. Exterior cells hyaline. Setulae, usually 2–3, rarely 4, 10–18  $\mu$  long, divergent; pedicels usually 4–6  $\mu$  long (Fig. 1). On the basis of the above morphological characters the fungus is identified as *Pestalotia cruenta* Syd. The culture has been deposited at the Commonwealth Mycological Institute, Kew, Surrey, England, as

No. 100476 and at Plant Pathological Laboratory of our Department.

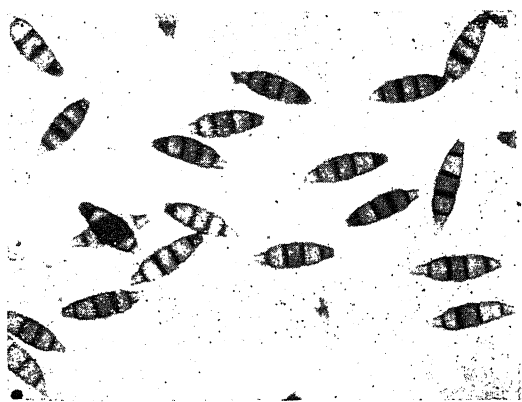


FIG. 1. Photomicrograph showing conidia of *Pestalotia cruenta*.

The organism could not infect healthy uninjured fruits but the pathogenicity of the isolate was established by inoculating healthy fruits by Granger and Horne's method<sup>3</sup> as well as by inoculating the fruits after injury.

Cross-inoculations were carried out on fruits of guava (*Psidium guajava* L.), banana (*Musa paradisiaca* L.), mango (*Mangifera indica* L.) and apple (*Pyrus malus* L.). Suitable controls were also maintained in all the cases. The organism could infect guavas only.

*Pestalotia cruenta* is rare in occurrence. Guba<sup>4</sup> (1960), p. 174) has mentioned that it has been isolated from living leaves of *Polygonatum lasianthum* Maxim, as well as from branches of *Prunus persica* (L.) Stokes from Japan and also from *Poinciana* (*Delonix*) from Philippine Islands. So far, *Pestalotia cruenta* has not been reported from India. Though several other species of *Pestalotia* are known to cause fruit rot of apple,<sup>8</sup> banana,<sup>1</sup> guava,<sup>8</sup> litchi,<sup>2</sup> mango,<sup>7</sup> and sapodilla,<sup>5</sup> etc., from various parts of the world, no species of this genus has been reported on fruits of *Embllica officinalis* from any part of the world, hence it appears to be a new host for this fungus.

We are grateful to Dr. Hopkins, Director, C.M.I., Kew, England, for confirming the identity of the fungus.

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### SODIUM ARSENITE-COPPER SULPHATE SPRAY FOR THE CONTROL OF CITRUS CANKER

CITRUS canker incited by *Xanthomonas citri* (Hasse) Dowson is of worldwide occurrence causing great damage to the citrus industry. In India, it is a disease of major importance. Several control measures including use of antibiotics have been suggested and employed all of which so far have remained ineffective. Antibiotics, which have revolutionized the therapy of human bacterial diseases, have generally not shown much promise in case of phytopathogenic bacteria. The high cost of the antibiotics, loss of potency during storage, development of resistant strains of bacteria are some of the factors which have limited the use of antibiotics.

In our experiments with bactericidal and bacteriostatic chemicals against phytopathogenic bacteria, we found that sodium arsenite was consistently active by inhibiting several *Xanthomonas* species at concentrations below 7 µg./ml. Literature also indicated that sodium arsenite had beneficial effect on the growth of citrus plants by having stimulatory effect (Liebig *et al.*, 1959). Consequently, after series of experimentations, the following spray schedule was finalized for testing it against citrus canker. 100 parts per million of sodium arsenite was combined with 100 p.p.m. of copper sulphate in water. Resulting mixture was near neutral in pH. Plants of *Citrus limon* (L.) Burm. f. (popularly known as lemon or acid lime in India) which were heavily infected by *X. citri* were selected in a big farm. Experiments were laid out statistically with different numbers of sprays and the results were evaluated statistically for the control of the disease. It was noticed that a single spray of this sodium arsenite-copper sulphate mixture killed the bacteria within a canker tissue, thereby preventing further spread of the disease on the new

shoots. Plants receiving three sprays during the season had more than 95% healthy leaves thereby indicating that the spray mixture was not only an eradicator but also a protectant. Infection from the neighbouring control plants did not spread into the sprayed plants. The data are of extreme significance since for the first time with a relatively cheap chemical it has been possible to control a bacterial disease of major importance. The fruits that were borne were clean without any bacterial lesions and of good market value. There was no evidence of any phytotoxicity even after repeated number of sprays. Detailed paper will be published elsewhere.

We sincerely thank Dr. M. J. Thirumalachar of Hindustan Antibiotics Ltd., Poona, and Professor W. V. Kotasthane of this Institute for valuable advice given from time to time; and Dr. M. V. Desai of B.A. College of Agriculture, Anand (Gujarat), for facilities to carry out field experiments and for assistance given by his staff.

Microbiology Department, M. K. PATEL.  
S.B. Garda College and A. C. PADHYA.  
B.P. Baria Science Institute,  
Navsari, Gujarat State, India,  
November 28, 1963.

L. Tiebig, Jr. G. F. Bradford. G. R. and Vanselow,  
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### TELIA OF RUST OF CASTOR ON CASTOR

The rust of castor *Melampsora ricini* (Biv.-Bern.) Passerini is a widespread disease wherever castor is cultivated. This rust has been known so far after the uredial stage only since the time the rust was described by A. de Bivona-Bernardi<sup>1</sup> in 1813 from Italy. Later on the rust has undergone some slight nomenclature changes and for all these it was the uredia only which was the basis by the previous workers.

Telia (*Melampsora ricini*) was collected by the author on the cultivated castor plants, followed by, on perennial plants of castor in the last week of April 1963. The rust normally breaks out as uredia first in the month of January every year in this part of the country and by the end of April the crop would have come to a close as regards the harvest of the capsules is concerned. By then gradual defoliation of old leaves would have taken place. The telia appeared as very insignificant colourless spots many times being outshone by the uredia. From the end of April when no more uredial

pustule appear in the field telia appear even on young leaves. The pustules are smooth surfaced and resemble small pin-heads and are amphigenous. Sometimes there will be a surrounding chlorotic area which is confined to dorsal side of the leaf. Telia is found at the serrated tips of the leaf margin also. This is the first record of the telia of this rust on castor. Noronha (1952)<sup>2</sup> while working on castor rust in Portugal had reported earlier that he could get the telial stage of this fungus by artificial inoculations on *Euphorbia marginata* and not on *R. communis*.

Grateful acknowledgements are due to Dr. L. G. Kulkarni for his interest and encouragement in these investigations.

Regional Res. V. RAVINDRA NATH VEMBAR.  
Pircom. M. NARAHARI REDDY.  
Indian Council of Agri. Res.,  
Himayatsagar P.O.,  
Hyderabad, Deccan, June 15, 1963.

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### URADO THELYPTERIDIS SPEC. NOV.

UREDIA amphigena, ut plurimum in pagin superiore, irregulariter dispersa, vulgo supra nervulos vel secundum nervulos, separata, nonnumquam inter se coalescentia, aureolutea in juvenili conditione, postea, pallide lutea, ovalia vel subglobosa, non-paraphysata, erumpentia, pulverulenta, irregulariter dehiscentia, subepidermalia peridio rudimentario ornata. Uredosporae aureo-luteae, nonnumquam praesertim in vetustioribus specimibus incolorae, sessiles, ovals, tenuibus parietibus praeditae, leves, poris germinationis inconspicuis, 11-19 × 20-38 μ (ut plurimum 15-17 × 28-34 μ).

Typus lectus foliis viventibus *Thelypteridis auritae* (Hook.) Ching. ad Darjeeling, mense octobri anni 1961, a R. P. Jha et sociis. Herb. I.M.I. 92134.

The rust was found on the living leaves of *Thelypteris aurita* (Hook.) Ching. in October 1962, in Darjeeling.

It apparently bears some resemblance to *Hylospora polypodii* Magn.<sup>1,2</sup> But it shows marked differences in having one kind of spores (smooth-walled only), inconspicuous germ pores and a rudimentary peridium. Further, no such fungus has been reported on this host

species. Therefore it is treated here as a new species.

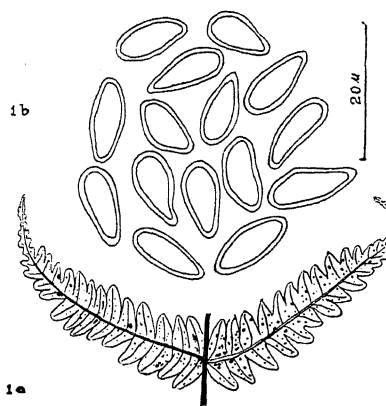


FIG. 1. (a) Sori of *Uredo thelypteridis* on *Thelypteris aurita*. (b) Uredospores of *U. thelypteridis*.

Uredia amphigenous mainly on the upper side, scattered irregularly, mostly on or along the veinlets, isolated sometimes coalescing with each other, golden yellow in fresh specimens, later may turn pale yellow in few cases of preserved herbarium specimens, oval or subglobose, non-paraphysate, erumpent, pulverulent, dehiscing irregularly, subepidermal with a rudimentary peridium; uredospores golden yellow, sometimes particularly in older specimens becoming colourless, sessile oval, thin-walled smooth, with inconspicuous germ pores, measuring  $11-19 \times 20-38 \mu$  (mostly  $15-17 \times 28-34 \mu$ ).

The author wishes to express his thanks to Rev. Fr. Dr. H. Santapau for the Latin diagnosis, to Dr. R. P. Jha and party for placing the material at his disposal and to Prof. P. N. Mehra and Prof. V. Puri for helping in the identification of the host.

Department of Botany, A. S. YADAV.  
Science College, Patna-5, July 8, 1963.

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#### IDENTIFICATION OF SUGARS AND FREE AMINO-ACIDS IN JUICE OF ASSAM LEMON

THE juice of Assam lemon, which constitutes about 30% of the fruit, contains 7.2% of total solids of which 0.91% are the total sugars. For identification of sugars and amino-acids, the peeled fruit is extracted in a waring blender

with sufficient amount of ethyl alcohol so as to obtain an 80% (v/v) alcoholic extract of sugars and amino-acids present in the juice. It is then filtered and the clear filtrate is used for chromatography. The sugars are identified both by ascending and descending paper chromatography using *n*-butanol : acetic acid : water (4 : 1 : 5) as the solvent system and the spots are developed by spraying with aniline hydrogen phthalate.<sup>1</sup> The sugars in the fruit juice and standard sugars are run simultaneously. The  $R_f$  values of the sugars are as given in Table I.

TABLE I

	Ascending	Descending
Sacrose	0.21	0.16
Glucose	0.27	0.20
Fructose	0.32	0.23

The free amino-acids are identified using *n*-butanol : acetic acid : water (4 : 1 : 1 and 4 : 1 : 5) as the solvent systems. The spots are developed as usual with ninhydrin reagent and compared with those developed for standard samples of pure amino-acids which are also run simultaneously. The  $R_f$  are as given in Table II.

TABLE II

	B:A:W (4:1:1) Ascending	Descending	B:A:W (4:1:5) Ascending	Descending
1. Asparagine	0.15	0.19	0.24	0.20
2. Glycine	0.21	0.26	0.32	0.25
3. Alanine	0.25	0.30	0.38	0.28
4. Glutamic acids	0.34	0.39	0.44	0.35
5. $\gamma$ -Amino butyric acid	0.42	0.48	0.58	0.47
6. Unidentified spot	0.69	0.71	0.75	0.70

The authors wish to express their thanks to Dr. B. N. Mitra, Director, for his kind interest in the problem. One of us (G. P. S.) expresses his thanks to the Council of Scientific and Industrial Research for the award of a Senior Research Fellowship.

Regional Research Laboratory, B. P. CHALIHA,  
Jorhat, Assam, G. P. SASTRY.  
July 26, 1963. P. R. RAO.

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## REVIEWS

**The Mathematical Theory of Viscous Incompressible Flow.** By O. A. Ladyzhenskaya. Translated from Russian by Richard A. Silverman. (Published by Gordon and Breach Science Publishers, New York and London), 1963. Pp. 184. Price \$ 9.50.

The book under review consists of the following six chapters:

**Chapter 1: Preliminaries.**—In this chapter some fundamental concepts about function spaces and inequalities used in the text are introduced.

**Chapter 2: The Linearized Stationary Problems.**—In this chapter the following three problems have been solved: (i) The motion of a rigid body in an infinite flow, (ii) motion of a liquid acted upon by volume forces in a vessel with rigid walls, whose spatial position is varied in a known way, (iii) motion of a liquid between two coaxial cylinders or two concentric spheres rotating with different velocities. Using the Hilbert Space  $L_2(\Omega)$ , it is proved that the linearized equations specifying the above problems have unique solutions.

**Chapter 3: The Theory of Three-dimensional Hydrodynamical Potentials.**—Here the classical method of hydrodynamical potentials, introduced independently by Odquist and Lichtenstein, is presented. This method has advantage over the functional method inasmuch as the former method enables the study of differential properties near the boundaries also.

**Chapter 4: The Linear Non-stationary Problem.**—Here the author, using the functional method, proves the existence of the unique solution of the linearized Navier-Stokes equations

$$\vec{V}_t - \nu \Delta \vec{V} = -\text{grad. } p + \vec{f}$$

$$\text{div. } \vec{V} = 0$$

$$\vec{V}|_s = 0, \quad \vec{V}|_t = \vec{Q}(\vec{r}).$$

**Chapter 5: The Non-linear Stationary Problems.**—The basic result proved in this chapter is the following: The stationary problems for general non-linear three-dimensional Navier-Stokes equations have at least one laminar solution for arbitrary Reynolds numbers and for series which need not be smooth. Moreover, smoother the functions describing the

external forces and boundaries, the better these solutions will be.

**Chapter 6: The Non-linear Non-stationary Problems.**—This chapter is devoted to the study of the boundary-value problem for a general system of Navier-Stokes equations under homogeneous boundary conditions. In the case of two-dimensional or axi-symmetric motion the problem admits unique solution in the large.

**Comments.**—This portion of the book gives some bibliographical notes and compares some of the results presented here with the results obtained by other investigators.

**Additional Comments.**—Here some references to the papers are noted down which deal with non-stationary boundary-value problems and which were published during 1960 while this book was being edited.

The reviewer has enjoyed this lucid and clear treatment of this rather difficult subject. The basic requirements for the understanding of the text are provided, however, it is felt that a reader will certainly need considerable study of functional analysis and basic theory of partial differential equations before he can really acquire a deep understanding of the matter discussed in the book.

The original Russian text is very carefully translated and the printing and get-up are excellent. It is a very welcome addition to the library of every serious worker in the theory of Differential Equations and Fluid Mechanics.

P. L. BHATNAGAR.

**Naturally Occurring Oxygen Ring Compounds.**

By F. M. Dean. (Published by Butterworths), 1963. Pp. 661. Price 120 sh.

Oxygen heterocyclic compounds occurring in plants have been known and studied from the early days of organic chemistry. More recently they have assumed considerable importance because of their relation with genetics, food and medicine. Though books of specialised type have been published, there has been none like the present one meeting the need of advanced students and research workers in one volume.

Wisely the scope of the book is restricted to prominent ring types having only oxygen as the hetero element. The first four chapters deal with compounds having single rings like furans



and the following four chapters with those having two rings like benzofurans and coumarins. After a chapter on xanthenes there are five chapters on the different flavonoids having the  $C_{15}$  skeleton. Then follows one on isochromenes dealing with compounds like phylloclucin and citrinin, one on complex compounds like rotenoids and 3-phenylcoumarin derivatives of the wedelolactone type and one on less common ring systems in which are included depsidones. The last chapter is on the Biosynthesis of these oxygen-heterocyclics. An appendix of 15 pages contains important matter published after 1961. There is an index of plants, micro-organisms and other sources and a compound and subject index; an author index has been omitted as unnecessary.

The subject-matter covers a large field. Several chapters begin with a discussion of the chemistry of the parent nucleus and this is followed by that of the individual or groups of compounds. The book provides a fund of information, and written by one with large experience in the field, it contains facts that have been critically appraised and well presented. That it is a very valuable addition to organic chemical literature and satisfies a real need will be clear from the fact that from the time it became available in the department of the reviewer it has been the one book most consulted and read.

T. R. SESHADRI.

#### Mechanical Properties of Engineering Ceramics.

Edited by W. Wurth Kruggel and H. Palmour III. (Interscience Publishers, New York), 1961. Pp. viii + 646. Price \$ 21.00.

The publication edited by W. Wurth Kruggel and Hayne Palmour III contains proceedings of a Conference conducted by the School of Engineering and College Extension Division, North Carolina State College, in collaboration with the Office of Ordnance Research, U.S. Army, N.C., March 9-11, 1960.

There are altogether 35 papers arranged in five parts, namely, (i) imperfections and deformation processes, (ii) thermal stress and mechanical properties, (iii) mechanical properties of oxide ceramics, (iv) mechanical properties of graphite, and (v) mechanical properties of non-oxide ceramics and composite materials. Discussion notes given at the end of most of the papers will help the reader in understanding the trend of discussion. The observations reported on  $Nb_2O_5$  whiskers and their strength properties are, in view of the unusual strength of whiskers, quite important.

The paper on 'Fatigue and Ceramics' contains an excellent review which will be quite stimulating to research workers in this little explored field. Mentioning the above two does not imply that other contributions are any way less important. The scope of the Conference, both in the variety of materials and phases of study was quite wide, ranging from low-melting glasses to highly refractory materials, from theoretical conceptions to methods of forming and testing of materials.

The increasingly higher performance demanded by designers from materials of construction under very exacting conditions and the limitations of traditional materials such as metals has made investigators turn more and more to ceramic materials and a few possessing remarkable structural properties have been developed. This work has been stimulated by research on the behaviour of materials other than those considered as ceramics such as the alkali halides, and the variety of techniques used to study them. The conception, scope and importance of ceramics have changed so radically that persons confined to prewar ideas of ceramics are bewildered with the new type of products, terminology and designation, engineering ceramics being one such, oxide ceramics another. Judged with this background, the publication of these papers in one volume is very welcome.

In view of the rapid advance that is being made in this developing field of research, the publication would, for obvious reasons, have a somewhat short range importance, since much of what is presented would soon be supplemented by new observations even by the authors themselves and also by others. In fact, no publications of this nature could claim better; it would only be indicative of a stage of stagnation, if it was otherwise.

The book should be of great value to a wide section of investigators studying this class of materials of great promise.

ATMA RAM.

#### Memoirs of the Society for Endocrinology.

No. 8—*Quantitative Paper Chromatography of Steroids*. Edited by D. Abelson and R. V. Brooks. (Cambridge University Press, London N.W. 1), 1960. Pp. vii + 103. Price 30 sh.

*Quantitative Paper Chromatography of Steroids* edited by D. Abelson and R. V. Brooks consists of the proceedings of a symposium held in July 1958 related to problems of the application of paper chromatography for the quantitative

estimation of steroids. The subject-matters dealt with consist of different aspects of quantitative estimation by paper chromatography and quantitative estimation of different steroids separately and in mixtures and biological materials. Discussions following the presentation of the articles are illuminating. This memoir is of great help for organic chemists and biochemists who are active researchers in the field. D. K. BANERJEE.

**The Modern Theory of Molecular Structure.**  
By Bernard Pullman. (Dover Publications Inc.), 1962.

Dr. Pullman is well known for his contributions in Quantum Chemistry and in this translation of his introduction to the subject we have a clear elementary picture of Valency and molecular structure. The undergraduate student will find the non-mathematical treatment an easy path to understanding the current approach and the bibliography at the end will lead him to a more advanced study. This is a welcome publication in paper back at a price within reach of the student.

S. V. ANANTAKRISHNAN.

**General Microbiology, 2nd Edition.** By R. Y. Stanier, M. Doudoroff and E. A. Adelberg. (Macmillan & Co., London), 1963. Pp. xiii + 753. Price 50 sh. net.

The first edition of this book published in 1958 in U.K. had to be reprinted in 1962. The appearance of this new edition is a good proof of its contribution to the teaching of Microbiology.

Referring to the revised edition the authors state: "Faced with the task of preparing a second edition of *General Microbiology*, we have found it necessary to rewrite completely many sections of the book. We have also made one major change in organization...this change of organization has permitted a much more coherent and unified development of such topics as cell structure, metabolism and nutrition." In result, the authors have provided up-to-date information in a masterly fashion in 753 pages.

The book achieves the objectives set forth and its advantages include the proper presentation of the material documented with many tables, diagrams, chemical equations and photographs. The volume admirably fulfils the requirements of a single volume text-book and heartily recommended. J. V. B.

**Physiology and Biochemistry of Algae.** Edited by Ralph A. Lewin. (Academic Press, New York and London), 1963. Pp. xxvii + 938. Price U.S. Dollars 32.00 or £ 11-9-0.

In the modern trends of research on algae, one may notice the emphasis shifting more and more into an experimental phase. Over a decade ago, Fogg had summarised in an admirable and concise treatise, *The Metabolism of Algae* (Methuen, 1953), the knowledge then extant in that discipline. The scope of the present book under review is far wider and comprises every aspect of phycology barring descriptive phases. It clearly sets out what has been achieved so far and on what lines it is desirable to orient research in future.

The text is divided into four main parts and three appendices. Part I contains 17 chapters dealing with various aspects of nutrition and metabolism. In this part, the following are dealt with: Light reactions in photosynthesis, assimilation of CO<sub>2</sub>, photoreduction and anaerobiosis, respiration, fermentation, heterotrophy, enzymes, organic micronutrients, nitrogen fixation, nitrogen assimilation, amino-acids and proteins, phosphorus uptake and metabolism, nucleotides and nucleic acids, sulphur, halogens, major cations and inorganic micronutrients.

Part II has 13 chapters dealing with composition of cells and metabolic products under these heads: storage products, cell walls, mucilages, fats and steroids, sulphactant lipids, chlorophylls, carotenoids, phycobilins, tannins, silicification, calcification, volatile constituents and extra-cellular products.

Part III comprises 19 chapters covering physiology of whole cells and plants. Topics dealt with are: permeability, salt and osmotic balance, temperature, invisible radiates, intracellular movements, gliding, taxes, flagella, laboratory cultures, cell division and expansion, nuclear-cytoplasmic interactions, polarity, growth substances and inhibitors, rhythms, sporulation, sexuality and biochemical genetics.

Part IV with 4 chapters deals with physiological aspects of ecology under freshwater algae, soil algae, marine plankton, seaweeds, lichens and endozoic algae.

The appendices deal with the classification of the algae mentioned in the book, uptake of radioactive wastes (of importance in view of the atom bomb tests as the radioactivity is passed on ultimately to man through the food chain) and antibiotics of algae, a line of work coming into prominence. Appendix A lists a large number of forms; it must be noted,

however, that comparatively only few have been intensively studied from several aspects. The importance in taxonomy of knowledge of physiology and biochemistry is stressed.

The author-, subject- and taxonomic-indices at the end are of considerable help and bear witness to the pains taken to make the book very useful.

It may be seen from the topics enumerated above that no aspect has been overlooked. All the chapters are well written, topics presented tersely and each is a review of almost all work done in that particular discipline. It is not possible to examine each chapter in detail in a review of this nature; one has to contend oneself by drawing the attention of the reader to the original, a perusal of which will be rewarding indeed. The manner in which cross-references are given indicate that the Editor's task has been very hard indeed in the arrangement of the matter to prevent redundancy.

It may not be out of place, however, to point out a few omissions to work which could have found a place under concerned topics. These are pointed out in the hope, as the Editor himself says in the Preface, "that in a few years, when this introduction to experimental phyco-logy will have become obsolescent", the "com-ments, criticisms and suggestions may serve in the building of a better Babylon". Nakazawa (Chapter 43, p. 653) states that the number of primary rhizoids in *Fucus* and *Pelvetia* is one. The reference to *Pelvetia* would appear to be to the Japanese species *P. wrightii* but the reference concerned<sup>3</sup> is not cited by him. For the European species, *P. canaliculata*, it has been shown<sup>9</sup> that the number of primary rhizoids is four and not one in which respect its affinity lies with the members of the Sargassaceæ. The author appears to have missed this point though reference is made to the account concerned elsewhere in the article. A rhythm in the release of the gametes in *Pelvetia canaliculata*<sup>9</sup> in relation to High Water Spring Tides has been observed which does not find a mention in Chapter 46; so also the interesting observa-tions of Bruce<sup>1</sup> on a sand inhabiting *Amphidinium*. Papers published on Indian diatoms on their nuclear changes during auxospore-formation, size of cells forming auxospores and factors inducing this process,<sup>4,8</sup> etc., do not find a place in Chapter 47. While the favourable effects generally of light on sexuality (Chapter 48) is stressed, it may be interesting to note that in *Navicula halophila*<sup>8</sup> a set-back to the consummation of the sexual

union of the gametes results in the presence of light.

While going through Chapter 52 on marine plankton, one wishes that some of the interesting observations,<sup>10,11</sup> made in the *Tropical Indian Waters* had found a place, for such investigations are few. Attention may be drawn to one or two points: The ratio among P:N:Si here is the same as that recorded in the temperate regions; and, that even during the peak bloom of phytoplankton, oxygen values do not go up much due to the fact that more O<sub>2</sub> is consumed by the rapidly dividing diatoms (the bulk of the phytoplankters) both in respiration and for uptake of silica in the formation of their cell walls. Several other environmental factors are also discussed therein. A reference to the contributions of Hardy,<sup>2</sup> Lucas,<sup>6</sup> and others<sup>5,7</sup> which stress the animal exclusion factor and the importance of extra-cellular products which condition the medium bringing about character-istic aquatic communities would also have been pertinent, reference to some of these, however, are found in Chapters 8 and 30 in some other context.

The above few remarks are not meant to detract the importance of the work, which appears to be the only outstanding publication on phyco-logy since the monumental work of Fritsch in two volumes *The Structure and the Reproduction of the Algæ*. The book is heavy reading but, as the Editor himself has stated in the Preface, "it is designed as a guide book, primarily for research workers and advanced students, to be useful, not entertaining". The book, though meant for algologists, will be of considerable interest to all students of plant physiology, for, many problems of physiology are easily solved using algæ as material for experiments. The book is well got up, paper and printing are good and very handy for its over 950 pages. It is worth the price but this may not be within the reach of many workers; the libraries should help in stocking more than one copy.

R. SUBRAHMANYAN.

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*Classics in the Theory of Chemical Combination*. Edited by O. Theodor Benfey. (Dover Publications, 180, Varick St., New York-14), 1963. Pp. xii + 191. Price \$1.85.

*Advances in Pharmacology* (Vol. 2). Edited by Silvio Garattini, Parkhurst and A. Shore. (Academic Press, Inc., New York), 1963. Pp. viii + 392. Price \$12.00.

*Digital Computer Design—Logic Circuitry and Synthesis*. By Edward L. Braun. (Academic Press, Inc., New York-3), 1963. Pp. xiii + 606. Price \$16.50.

*International Review of Neurobiology* (Vol. 5). Edited by Carl C. Pfeiffer and John R. Smythies. (Academic Press, Inc., New York-3), 1963. Pp. xi + 439. Price \$14.00.

*Cinicrography in Cell Biology*. Edited by George G. Rose. (Academic Press, Inc., New York-3), 1963. Pp. xiv + 500. Price \$18.50.

*An Introduction to Numerical Mathematics*. By Edward L. Stiefel. (Academic Press), 1963. Pp. x + 286. Price \$6.75.

*Mathematics in Science and Engineering*, Vol. 11. *Differential Forms with Applications to the Physical Sciences*. By Harley Flanders. (Academic Press), 1963. Pp. xiii + 203. Price \$7.50.

*Progress in Astronautics and Aeronautics*, Vol. 11. *Power Systems for Space Flight*. Edited by M. A. Zipkin and R. N. Edwards. (Academic Press), 1963. Pp. xvi + 943. Price \$13.50.

*A Key for the Identification of the More Common Planktonic Copepoda of Indian Coastal Waters*. By L. R. Kasturirangan. Edited by N. K. Panikkar. (C.S.I.R., New Delhi), 1963. Pp. 87. Price Rs. 10-00.

*The International Astrophysics Series*, Vol. 6. *Stellar Interiors*. By D. H. Menzel, P. L. Bhatnagar and H. K. Sen. (Chapman & Hall, London), 1963. Pp. xiii + 313. Price 65 sh. net.

*Celestial Objects for Common Telescope*, Vol. 1. *The Solar System*. By the Rev. T. W. Webb. Edited and revised by Margaret W. Mayall. (Dover Publications). Pp. 255. Price \$2.25.

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## SCIENCE NOTES AND NEWS

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### Award of Research Degree

Osmania University has awarded the Ph.D. degree in Botany to Miss G. E. S. Mary for her thesis entitled "Studies on the Leaf Blight of Corn Caused by *Helminthosporium turcicum* Pass."

### New Type of Polymerization

A polymer, as is well known, is a material whose molecules consist of several hundred, and in many cases even several thousand, base units or monomers. There are two well-known processes by which monomers are polymerized. A class of monomers is polymerized by what is called addition polymerization. Another class of monomers polymerizes by a condensation (or polycondensation) process. In all some 40 to 50 base units have the capacity to react with each other in one of the two ways, although

nature has confronted us with more than a million organic polymers.

At the Institute of Organometallic Compounds, USSR, a new type of polymerization reaction, called *polyrecombination*, has been developed by which a number of new substances, not ordinarily possible by the above-mentioned two processes, have been produced. The polyrecombination process is in short as follows: To the monomer to be polymerized, placed in a specially set up glass assembly, is added a solution of tertiary butyl hydroperoxide. On heating, the peroxide breaks up into free radicals. The free radicals attack the monomer and remove its hydrogen atoms, whereby the monomer molecules behave like free radicals and tend to combine with each other, thus turning into a dimer. More peroxide is added to the dimer and the process is repeated to produce a tetramer. The tetramer is turned into an

octamer, and so on until the desired degree of polymerization is attained.

The effect of peroxide on organic substances had been known before, but so far it has been used to obtain dimers only. The work of V. Korshak and S. Sosnin of the Institute of Organometallic Compounds has enabled the necessary conditions to be determined for polyrecombination whereby reactions can be carried on successively until high polymers are obtained.

#### Synthesis of Insulin Molecule

At a Conference on Proteins and Polypeptides held recently in Michigan, P. G. Katsoyannis, A. Tometsko and K. Fukudo of the University of Pittsburgh announced their successful synthesis of the insulin molecule, the first synthetic insulin to exhibit biological activity. Consisting of 51 amino-acid units, insulin is the largest protein-like molecule yet synthesized in the laboratory. Synthesis of the pituitary hormone ACTH, consisting of 39 amino-acid units, was achieved only recently (see *Current Science*, 1963, 32, 576).

The insulin molecule consists of an 'A' chain of 21 amino-acid units, and a 'B' chain of 30. The chains are joined at two points by pairs of sulphur atoms; a third pair of sulphur atoms forms a secondary link between segments of the 'A' chain. The synthesis reported by the Pittsburgh workers was effected in two stages. The 'A' chain was first synthesized and its confirmation came from G. H. Dixon of the University of Toronto, who combined a sample of synthetic 'A' chain with the 'B' chain of natural insulin to obtain an insulin with full biological activity. More recently they produced a preparation containing the synthetic 'B' chain. Although the concentration of the 'B' chain was low in this preparation, a sample was sent to Dixon who found slight but definite hormone activity when the sample was reacted with either natural or synthetic 'A' chain.

The 'A' and 'B' chains synthesized by the Pittsburgh group are believed to have the amino-acid sequence of sheep insulin. (Amino-acid sequences differ slightly in insulins from different species but this has little effect on the activity of the hormone.) In addition to providing new support for the insulin amino-acid sequence originally worked out by Frederick Sanger, the synthesis is expected to advance the understanding of diabetes and hormone action.—(*Scientific American*, December 1963.)

#### Rare Blood Type

What is considered to be one of the rarest blood types has been reported from the Blood Bank in Brisbane, Queensland, Australia. An apparently normal blood donation from a woman aged 29 could not first be identified. Exhaustive tests seemed to convince that it was a case of the rare "Anti-V.E.L." type. From serum secured from New York, and with the co-operation of other overseas scientists, it was established that the Brisbane woman was an RH donor with VEL negative blood with antibodies. A second donation by the woman after three months has helped overseas scientists to confirm the finding. Already two more VEL negatives have been found in the North Queensland, in the sugarcane coastal city of Cairns, and Brisbane Blood Bank is likely to build a reserve of this rare blood for world consumption.—(*Australian Science Newsletter*.)

#### The Moon and the Weather

The age-old belief that the moon has an effect on the weather—usually discredited by scientists in general and by meteorologists in particular—seems to have received scientific support from the recent work of the Radiophysics Division of Australia's CSIRO. An analysis of past weather records has shown that heavy rain is more likely during the first and third weeks of the Lunar month—particularly three to five days after both new and full moon. Also earlier observations had revealed that peaks in average rainfall were often preceded by a shower of meteors or shooting stars about 30 days earlier. This had led to the hypothesis that a significant portion of rainfall is triggered off by dust particles resulting from the impacts of meteors on the lower atmosphere, these particles acting as nuclei for cloud condensation.

To explain moon's effect on rainfall the theory is put forward that the moon might somehow deflect meteoric dust away from the atmosphere when it is in certain phases with respect to the earth and the sun, so that fewer freezing nuclei are provided to trigger off rainfall. Radio and radar observations seem to confirm this finding, namely, that the number of freezing nuclei in the atmosphere varies with the phases of the moon.—(*Australian Science Newsletter*.)

#### Application of Microwaves in Building Research

Experiments performed by the British Building Research Station, London, show that microwaves might replace pneumatic drills in

rock splitting, and maybe destroy dryrot in brickwork and woodworm in timber. Using a 10-KW, CW 2450-Mc generator inserted through 18-inch holes into granite, cracks were produced in three minutes. A 20-KW, 915-Mc source aimed at reinforced concrete (a 5 ft. square, 9-inch thick wall) caused explosions that separated the concrete from reinforced roas. —(*Electronics*: November 29, 1963.)

### Theory of Metallic Diamond

The diamond and the related zincblende type structure is a consequence of tetrahedrally coordinated atoms, with predominately covalent binding. The Group IV elements, germanium and silicon as well as carbon and gray tin, crystallize in such a structure, as do many of the binary equi-atomic compounds formed between Group III and V elements, and some between Group II and VI elements. The semiconducting properties of these substances have received a great deal of attention, and their band structures have been explored by a variety of techniques including, recently, the effects of pressure.

One result of importance that has emerged from these high-pressure studies is the transition of these substances under suitable conditions of pressure and temperature, from semiconducting to metallic states. The phase change is marked by a large increase in density and a rise in the number of equivalent near neighbours from four, characteristic of these materials at low pressure, to six in the new phase. The generality of this phenomenon calls for a general theory for this transformation, based perhaps on a principle so far unrecognized.

Professor W. F. Libby suggests what may be called a crystal-resonance theory, which also envisages a new metallic phase of carbon to be obtained by compression of diamond—the “metallic diamond”. The eight electrons available for bonding in the low-pressure tetrahedral structures just fill the four available orbitals and at the same time establish equivalent bonds to all near neighbours. Under high pressure, as is seen from experiments, the forced transformation to a more densely packed structure with more than four neighbours, and without any increase in the number of bonding electrons (or available orbitals) causes the

system to become metallic. Now, it is known that for ordinary metals vacant orbitals exist from which conducting bands readily form. In the case of the new metals discussed here, it is suggested that it is not necessary to have vacant orbitals but that metallic conduction can result purely from the resonance condition that must exist in a structure which has more, truly geometrically equivalent, near neighbours than there are possible bonds. Of course, at very high compressions all matter will become metallic since all electron levels are raised by compression and the ionization potential must fall to zero eventually. But before this occurs the new class of *resonating metals* will occur because the degree of compression necessary to the raising of the co-ordination number above the bond number probably is less than that for enforced ionization.

The central point in the proposed theory is that the condition of geometrical equivalence means that the Franck-Condon principle offers no barrier to electronic resonance with the consequence that resonance occurs throughout the region of geometrical equivalence which may be crystal-wide. In graphite, for example, which is the two-dimensional case for our system, there are one orbital and one valence electron per atom with three equivalent neighbours. For graphite it is clear both theoretically and experimentally, that the two-dimensional metallic state exists. Thus we see that for this system at least *bond resonance without vacant orbitals can produce the metallic state*. “It is our theory,” says Libby, “that the new class of metals discussed here is the three-dimensional analogue of the two-dimensional metal graphite. There are four orbitals and four valence electrons with four neighbours in the tetrahedral lattices of diamond which on compression transform into the six near-neighbour structures of metallic tin. These four bonds have to satisfy six atoms. The resonance state is possible because the Franck-Condon principle has been satisfied by the location of the atoms in equivalent positions, and, as a consequence, the full crystal is set into three-dimensional resonance such that the entire crystal becomes one molecule at least at the absolute zero of temperature.”—(*Physical Review*, 1963, 130, 548.)

# THE VISUAL SYNTHESIS OF COLOUR

SIR C. V. RAMAN

## 1. INTRODUCTION

OUR visual organs possess in a high degree the faculty of distinguishing between the colours exhibited by the spectral components into which polychromatic radiation has been resolved by a dispersing apparatus such as a prism or a diffraction grating. On the other hand, without the aid of such apparatus, our eyes fail to recognise the presence of distinct spectral components in composite radiation. What they do perceive is the resultant sensation excited by it which is also (rather loosely) termed as the colour of the light. The number of such composite colours which can be distinguished from each other in appropriate circumstances is enormously larger than the number of monochromatic radiations which can be recognised as different in colour in a perfectly resolved spectrum. This is not surprising, since the nature of the polychromatic radiation, in other words, the distribution of energy in its spectrum admits of an infinite number of possible variations.

A knowledge of the relationship between the spectral nature of composite light and the character of the visual sensation which it excites is of great technical importance in various arts and industries. But it is no less important in relation to our understanding of the basic aspects of the physiology of vision. The only procedure for obtaining such knowledge which is not biased or invalidated by the prior acceptance of *ad hoc* hypotheses and can therefore be trusted to lead us to the real truth of the matter is the study of the relationship which actually exists between colour and spectral composition in a very large number of actual cases and the deduction from the results of such study of general principles which are found to be valid in all cases. These considerations led the present writer to undertake the

systematic examination of floral colours in relation to their spectral composition. The results of the investigation of numerous individual cases were described and the inferences to which they pointed were set down in a recently published memoir by the author (Reference 1). Since then, many more examples have been studied and satisfactory spectrograms illustrating the observed relationships in various cases have been recorded. The investigation has also been extended to other classes of objects exhibiting colour, *viz.*, gemstones (both natural and synthetic) and various technical products including especially dyed textiles. The results emerging from all these studies are in complete agreement with each other, as also with the conclusions arrived at in the memoir cited above. They make it evident that the geometric representations of the results of colour synthesis which have found favour for over a century, *viz.*, the Maxwellian colour-triangle and the more recently adopted XYZ system, are based on a totally misconceived ideology and that the results indicated by these diagrammatic representations of colour are contradicted by the facts of observation.

## 2. THE AFRICAN VIOLET AND OTHER FLOWERS

The spectral composition of the colours of some hundreds of different floral species and varieties have been examined by the author. Amongst those more recently studied, three examples have been chosen as meriting special description in the columns of *Current Science*. The first example is that of the flowers of the plant known botanically as *Saintpaulia ionantha*, and more popularly as the African or Usambara violet. It is a small herbaceous perennial plant of great beauty which is almost stemless with a rosette of long stalked hairy leaves. The flowers are coloured deep purplish violet and

resemble violets in shape though in size they are much larger (see Fig. 1). Throughout



FIG. 1. Leaves and Flowers of the African Violet. the year, the plant flowers freely. The second example belongs to the very interesting class of plants known as the Iris which

*Iris germanica* which has sword-like leaves and bears flowers on erect stalks. They have a beautiful purplish-blue colour, a drawing of one such flower spread out flat on a sheet being reproduced as Fig. 3. The third example studied is a ground orchid which bears flowers on long spikes which may be 2 to 3 feet long. A group of such flowers appearing at the end of a stalk is illustrated in Fig. 5. The plant has been identified from the published descriptions and illustrations as the orchid *Spathoglottis plicata*. The most attractive of its varieties is one which bears flowers having a colour which may be described as a purplish-red. Spectrograms obtained with these three flowers are reproduced as Fig. 2, Fig. 4 and Fig. 6 respectively. We shall proceed to describe the features exhibited in these spectrograms and comment on their significance in relation to the theory of colour perception and

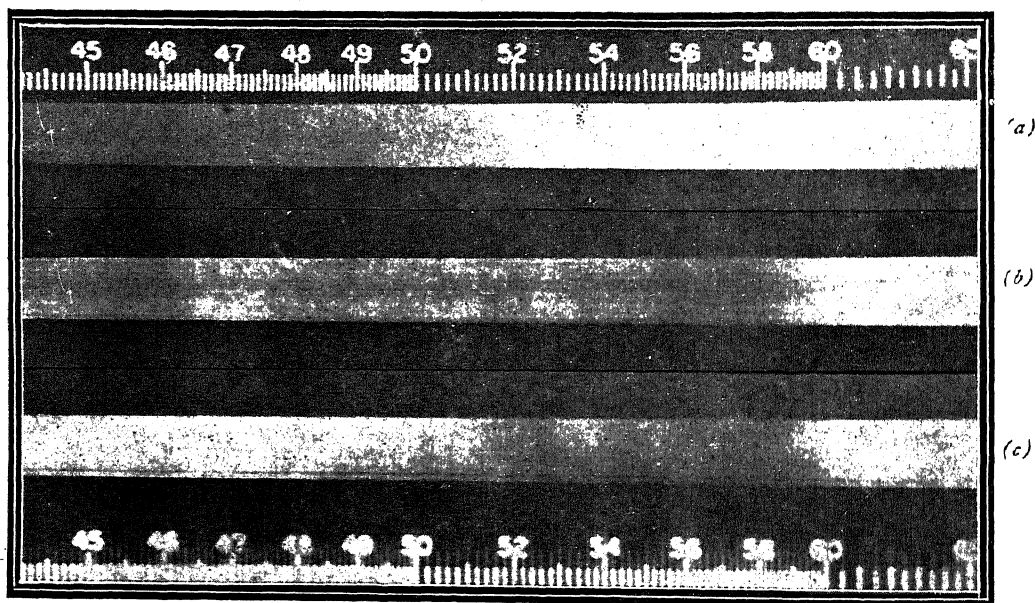


FIG. 2. Spectrum of the African Violet. (b) by transmission; (c) by reflection.

bear curiously constructed flowers of attractive and gorgeous colours. The particular plant whose flowers have been examined is

the visual synthesis of colour, the latter being the special subject of the present communication.



### 3. THE SPECTROSCOPIC OBSERVATIONS

The spectral composition of the colours of flowers may be studied either by transmission through their petals or by reflection at their

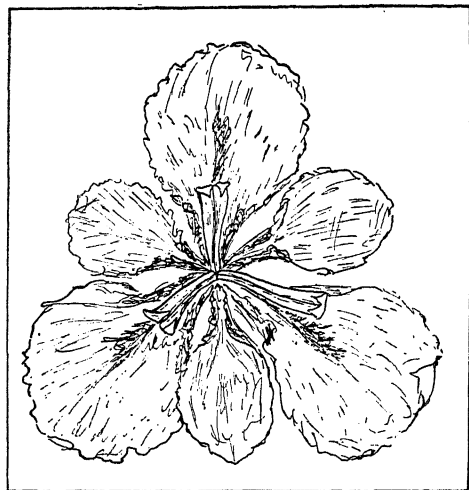


FIG. 3. Petals of the Iris Flower, spread flat. surfaces. In the case of the African Violet, the upper and lower surfaces of the petals present a slightly different appearance, the

of a more saturated hue than that seen by transmission. The most striking feature observed in the spectrum of either the transmitted or the reflected light is an intense absorption in the yellow region of the spectrum. This covers the region between  $560 \text{ m}\mu$  and  $590 \text{ m}\mu$  and is very clearly exhibited in the two spectrograms reproduced as Fig. 2 (b) and 2 (c) respectively. Figure 2 (a) is a comparison spectrum of the light source employed, viz., a tungsten-filament lamp. Remarkably enough, the red of the spectrum is conspicuous both in the transmitted and in the reflected light. It is evident, however, that considered in relation to the rest of the spectrum and especially the blue and violet, it has suffered a weakening. Further, it is noticed visually that in the spectrum of the reflected light, the red of the spectrum is split into two parts by a darker region located at  $640 \text{ m}\mu$ . The spectrum also reveals a weak absorption in the green located at about  $530 \text{ m}\mu$ . But these are relatively minor features. As is clear

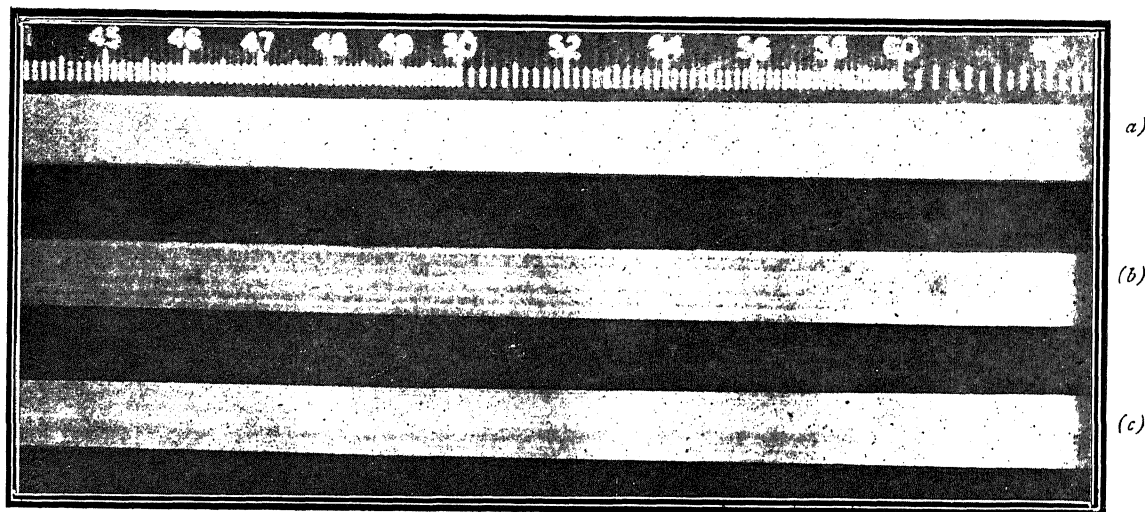


FIG. 4 Spectrum of the Iris. (b) by transmission; (c) by reflection.

upper being of a deeper and more saturated violet hue. The colour as seen by reflection at the upper surface is likewise deeper and

from the reproduced spectra, the major feature is the suppression of the relatively narrow yellow sector of the spectrum,

As stated earlier, the petals of the Iris exhibit a beautiful purplish-blue colour. The spectra of the light transmitted and reflected by its petals are reproduced in Fig. 4 (b) and Fig. 4 (c) respectively, Fig. 4 (a) being the comparison spectrum of the light source. It will be noticed that the spectra exhibit an absorption in the yellow sector between  $560\text{ m}\mu$  and  $580\text{ m}\mu$ , but this is not so strong as in the case of the African Violet.



FIG. 5. [Bunch of Flowers of the Orchid.

comparison spectrum of the light source, Fig. 6 (a).

Two strong absorption bands are noticed, one between  $580\text{ m}\mu$  and  $590\text{ m}\mu$  in the yellow sector and another between  $540\text{ m}\mu$  and  $550\text{ m}\mu$  in the greenish-yellow part of the spectrum. A third and much weaker absorption is also noticed at  $510\text{ m}\mu$ , but the rest of the green between  $510\text{ m}\mu$  and  $540\text{ m}\mu$  is transmitted freely. Neither the violet and blue sectors between  $400\text{ m}\mu$  and  $500\text{ m}\mu$  nor the red sector show any noticeable weakening or extinction.

#### 4. THE SIGNIFICANCE OF THE RESULTS

We may sum up the foregoing by the statement that the absorption of the yellow is the major common feature in the spectra of the flowers in all the three cases, and that the large differences in their observed colours arise from certain relatively minor differences in the character of their spectra.

The highly important role played by the yellow region of the spectrum in determining the observed colour of composite light by reason of its presence or of its absence as the case may be, emerged very clearly from the studies described in the author's memoir on floral colours cited earlier. It was there

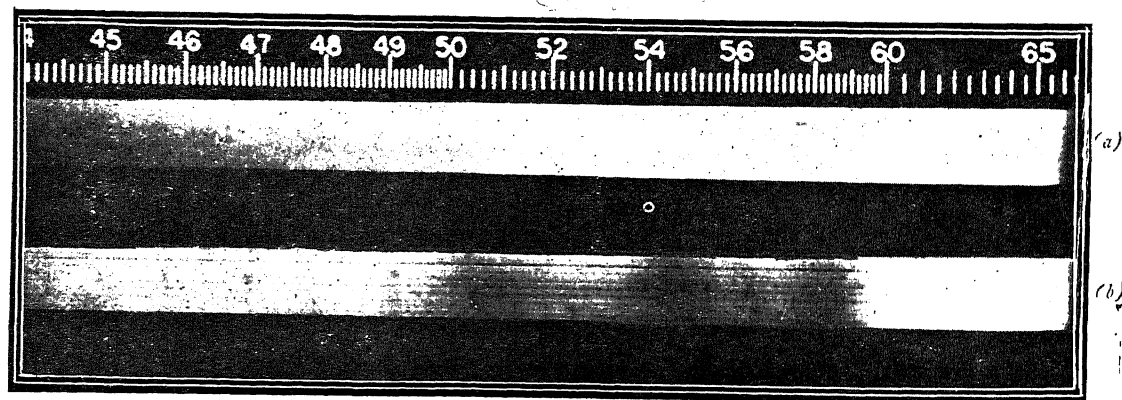


FIG. 6. Transmission Spectrum of the Orchid with Comparison Spectrum.

The spectrum of the light transmitted by the petals of the orchid *Spathoglottis plicata* is reproduced in Fig. 6 (b), alongside of the

shown that the removal of the yellow from the spectrum, other parts of the latter remaining the same, results in the observed sensation

being the colour familiarly known as *purple*. Numerous illustrations of this fact were noted in the study of floral colours. The same result is demonstrated in a very striking fashion by technical products of various sorts, as for example, by silks which have been dyed a purple colour. In the author's collection of doctor's gowns acquired at various times, there are three examples of this, which may be referred to respectively as Calcutta-1922, Glasgow-1930 and Delhi-1964. The Calcutta gown is made entirely of purple silk. The Glasgow gown is of wool dyed scarlet, but it has purple silk facings and the hood is also lined with purple silk. The Delhi gown is of scarlet-coloured silk, but the cap is of purple velvet with edgings and an inside lining of purple silk. The three examples of purple silk exhibit three different shades of colour. But the spectral composition of the colour is essentially the same in all three cases, *viz.*, a complete or nearly complete extinction of the yellow sector of the spectrum in the 560 m $\mu$  to 590 m $\mu$  region, while the violet, blue, green and red sectors of the spectrum are present with their normal relative intensities as visually observed.

In the Maxwellian colour triangle, as also in the well-known XYZ representation of the results of colour synthesis, the purples appear on a straight line joining the two extremities of the spectrum, *viz.*, red and violet. The

purples appear in the diagram opposite to the bend in the curve representing the green part of the spectrum extending from 500 m $\mu$  to 550 m $\mu$ , the purple and the green being complementary colours. In other words, the diagram contemplates that the purple sensation results from the removal of the green from the spectrum. Actually, as we have seen, the purple sensation results from the yellow sector of the spectrum being removed, and it is experienced in a fully saturated form even though the green part of the spectrum is present in full strength. Then, again, as has already been set out in the author's monograph, there are numerous flowers in which the green part of the spectrum is partly or wholly extinguished by absorption, while the rest of the spectrum is not weakened or absorbed. In all such cases, the colour exhibited is *not a purple*, but is a colour which ranges from a pale to a deep rose-red depending on the degree of completeness of the extinction of the green sector.

Thus, quite apart from any question of theory or logic, the actual facts of experience show that the ideology on which the Maxwellian colour-triangle and its more recent modifications are based is false and totally misconceived.

1. "Floral Colours and the Physiology of Vision." Memoir No. 137 of the Ramun Research Institute, *Proc. Ind. Acad. Sci.*, 1963, 58, 57.

## THE INDIAN ACADEMY OF SCIENCES

THE following have been elected to the Fellowship of the Academy with effect from 1st January 1964:

(1) Dr. T. R. Anantharaman, Professor and Head of the Department of Metallurgy, Banaras Hindu University, Varanasi-5; (2) Dr. Dev Satya Nand, Professor of Psychiatry, All-India

(3) Dr. C. Gopalan, Director, Nutrition Research Institute of Medical Sciences, New Delhi-16; Laboratories, Indian Council of Medical Research, Hyderabad-7; (4) Dr. M. G. K. Menon, Professor of Physics, Tata Institute of Fundamental Research, Bombay-5; (5) Dr. J. R. Merchant, Associate Professor of Organic Chemistry, Institute of Science, Bombay-1.

ENRICHMENT CULTURE METHODOLOGY AND THE FAMILY  
PSEUDOMONADACEAE WINSLOW ET AL.

J. V. BHAT

ESSENTIALLY, the enrichment culture methodology is an application, on the microscale, of the Darwin's principle of natural selection. The methodology had its modest beginning in the success achieved by Winogradsky at the end of the last century in the isolation of nitrifying bacteria but the origin of the principle involved can be traced back to the work of Pasteur. This technique has since been perfected mostly by the "Delft School" of Microbiology led by Beijerinck whose success in the isolation of *Azotobacter* at the turn of this century marked the first milestone in this direction. During the past few decades the method has been put to use widely and has proved to be one of the most powerful tools available to the microbiologist for isolating any bacterium possessing a specific physiological property, provided, of course, the bacterium exists in nature. The practice of using animals for isolation purposes, as in the case of *Pasteurella pestis* of plague or *Diplococcus pneumoniae* of lobar pneumonia, represents application of this methodology. Addition of 6-8% NaCl in media for isolation of staphylococci or raising of pH for the isolation of cholera vibrios are other instances of enrichment. Attempts at designing media for enrichment of specific microbial species have, in fact, continued unabated so far.

The family *Pseudomonadaceae* (Bergey's Manual, 1957) includes 12 genera, listed below, in which are placed 244 species (excluding another 14 species considered to be worthy of incorporation into one of the 12 genera, viz., *Xanthomonas*).

Genera	No. of species in each
<i>Pseudomonas</i>	149
<i>Xanthomonas</i>	60 + Addendum 14 sp.
<i>Acetobacter</i>	7
<i>Aeromonas</i>	4
<i>Photobacterium</i>	4
<i>Azotomonas</i>	2
<i>Zymomonas</i>	2
<i>Protaminobacter</i>	2
<i>Alginomonas</i>	5
<i>Mycoplana</i>	2
<i>Zoogloea</i>	2
<i>Halobacterium</i>	5

Perhaps, this family has in it more species than any other, notwithstanding the 343 sero-

types recognized in the Tribe *Salmonelleae*. Members of *Pseudomonadaceae* grow well and fairly rapidly on the surface of media; are generally aerobic, but may be fermentative, e.g., *Aeromonas* and *Zymomonas*. The use of non-fermentable substrates as carbon sources, for example, usually results in the enrichment of obligate aerobes—the members of the genus *Pseudomonas*. The use of alcohols, ethanol in particular, results in the enrichment of *Acetobacter*. Pseudomonads are both ubiquitous and pervasive and may be isolated from soil, water, sea-water and heavy brines, e.g., water of the dead sea, plant tissues and animal sources. Generally speaking, members of the family *Pseudomonadaceae* can be isolated easily from enrichment cultures.

For the purpose of the present paper, discussion will be limited to the principal and perhaps the most active genus, *Pseudomonas*. Organisms of this group are extremely varied in their nutritional requirements and metabolic pathways so much so that, apart from their morphological peculiarities, there is not much in the taxonomic literature that can be depended upon to characterize them. No doubt some are pathogenic to man and other animals (interestingly, these organisms can infect both warm and cold blooded animals), some to plants, and some are even toxigenic and/or endowed with the capacity to produce antibiotics. In fact, the genus includes such diverse forms as those that may be classified as psychrophilic and mesophilic; recently, even a thermophilic form has also been recognised. The outstanding property of the genus, however, is its oxidative versatility. Almost all the organic compounds can be attacked by one or the other strain or species. Indeed, species decomposing as many as 200 different naturally occurring organic compounds have been recognized. From the results so far recorded of the enrichment cultures set with organic compounds, it would appear that for every organic compound there exist some pseudomonad capable of attacking it, and this fact should explain the disappearance of organic matter from the surface of the earth and justify the pseudomonads being regarded as the "scavengers" of nature. Indeed, as early as in 1910, Conn had recognised 4 main groups of bacteria as occurring in soils; his group II

represents those related to *P. fluorescens* and comprising 10% of the total soil flora and group III include all the short-rod forms (accounting for 40-70% of the population and for all the major transformations in soils) and all these perhaps are pseudomonads.

The principal members in the genus are *P. aeruginosa* and *P. fluorescens*. They are, in general, organotrophs, capable of giving rapid and luxuriant growth in the presence of a wide variety of organic compounds. Whereas a few members can do away with combined nitrogen, a large majority depend upon combined nitrogen for growth; some even bring about denitrification (*P. stutzeri*; *P. denitrificans*). The fluorescent species in the genus produce a pigment of unknown chemical nature whereas the rest may produce pyocyanine, a water-soluble, phenazine compound which acts like an acid-base indicator turning red in acid and blue in alkaline conditions.

It is of extraordinary interest to retail here the nature and characteristics of the pseudomonads which present a study in contrasts. For example, we have at one end species which are morphologically non-motile and, if at all motile, possessing only single polar flagellum, like *P. fluorescens*, whereas we have, at the other extreme, those with 2 to 6 polar flagella (*P. reptilivora*), though ordinarily we encounter only species with 1 to 3 polar flagella. Likewise, morphologically, they may be either coccoid, straight rods or even curved into vibrios. Culturally speaking, we have on one hand as transparent a species as *P. translucida* and as beautifully curved and smooth a species as *P. convexa*, as we have, on the other hand, as hairy, woolly and shaggy species like *P. lasia* and as full of wrinkles as the *P. rugosa*. What is more strange, we can have in cultures as coherent a species as *P. cohaerens* along with as uncertain (going about) a culture as *P. ambigua* or as spreading a culture as that of *P. effusa*; or, if one so desires, as extraordinary a form as *P. mira* to as common-place a species as the one described by Smith, Bryan and Clara, and called *P. lachrymans*, because it sheds tears, on cucumber leaves though!

What a gulf exists between the colourless (achromogenic) *P. aeruginosa* strains and the multicoloured *P. polycolor* or peacock's tail-like *P. pavonaceus* or between the earthbound black to reddish-brownish *P. nigrificans* and the celestial rainbow-coloured *P. iridescens*! There exists, indeed, a wide spectrum of *Pseudomonas*

species producing diffusible pigments of different colours, such as blue, green, violet, lilac, purple or red even as there exist those that produce non-diffusible bright red or yellow. Similarly, species exist which produce slime (*P. myxogenes*) and contrastingly others, which cause precipitation (*P. calciprecipitans*). In a like manner, we have at one end crack-producing scanty species as *P. rimae-faciens* and at the other, such prolific growth-producers as to deserve comparison to man's beard, viz., *P. andropogonis*, even as there exist the bond-loosening types as *P. desmolytica* which stands in contrast to jointed *P. geniculata*; species fallen and downtrodden as *P. lapsa* which in itself provides contrast to the exalted and halo-producing *P. coronafaciens*. Above all, the genus contains on one hand such repulsive skunk-like odour-producers as *P. mephitica* as we have on the other those which produce as appealing a fragrance as that of jasmine (*P. smaragdina*); or such simple entities as those that can attack only simple substrates as oxalate and formate, but not even glucose (*V. oxaliticus*) or those that attack such complex substrates as cellulose (*P. effusa*), or agar (*P. gelatica*), though majority of the members display their activities on diverse types of less complex organic compounds occurring in nature. Ordinarily, the members carry on a complete oxidation of alcohols, acids and sugars; sometimes they accumulate products as gluconic or ketogluconic acids. A spectacular example of incomplete oxidation is, at the same time, witnessed in the oxidation by *P. indoloxidans* of indole, wherein 2 molecules of indole are oxidized and condensed to form the pigment indigo-blue.

Though no claims can be made of successful isolation of all *Pseudomonas* species by the application of enrichment culture methodology, the experience gained by us during the past two decades shows that enrichment of many a *Pseudomonas* species can be effected by the use of suitable media and inocula and providing proper cultural conditions. Thus, for example, if formate is the only carbon source available in the mineral medium containing inorganic nitrogen, one can reasonably expect to isolate from soil *P. fluorescens*. With oxalate, either *P. oxaliticus* or *V. oxaliticus* gets enriched. With hippurate, it would end up in the isolation of *P. convexa*, with fumarate *P. hydrophila*, with riboflavin *P. riboflavina*, with creatine *P. ovalis*, and with chitin, *P. chitinovora*. Indeed, the invisible world of *Pseudomonas* appears to

be as diversified and interesting as the visible kingdom of plants and animals on the one hand and the chemical world of elements and compounds on the other, though a *Pseudomonas*

which laughs, or, makes us laugh (like NO), still remains to be discovered! Perhaps enrichment culture methodology holds the answer to this, too!!

## EMBRYOLOGY OF SOME INDIAN GRASSES

J. VENKATESWARLU AND P. INDIRA DEVI

Department of Botany, Andhra University, Waltair

**A**LTHOUGH embryology of Gramineae has received some attention many Indian grasses have yet to be worked out in detail. A review of the previous literature reveals several interesting features of reproduction other than sexual. Hence a comprehensive study seemed worthwhile and 20 species of Indian grasses distributed among 5 tribes have been so far investigated by us here (Table I). A general account of the observations is given below.

Microspore mother cells are surrounded by an epidermis, an endothecium, a middle layer and a glandular tapetum of binucleate cells. Meiosis in pollen mother cells is normal, the division being successive. Isobilateral tetrads are common. Pollen grains are usually shed at 3-nucleate stage.

Ovary is superior, unilocular and uniovulate. Ovule is bitegmic, anatropous or slightly campylotropous. The inner integument grows faster and forms the micropyle. The outer integument completely covers the ovule except the micropylar region or in some grasses it encloses only less than two-thirds of the ovule. The hypodermal archesporium is single-celled but 2 to 3 sporogenous cells are rarely observed lying adjacent to one another in a few members. No parietal cell is present. The nucellar epidermis below the micropyle does not divide in members of the subfamily Pooideae but it divides cutting off wall layers periclinally in the subfamily Panicoideae. Meiosis is regular. The chalazal megaspore is functional. The development of the female gametophyte is according to the Normal Type. Antipodals are well developed. They vary in their number and also in the number of their nuclei. They are chalazal in position in some members but are laterally displaced in others. Presence of T-shaped and linear tetrads, lateral displacement of the antipodals, persistence of the

degenerating mass of the upper three megaspores sometimes even up to 4-nucleate stage, are common in the tribe Eragrostae.

Fertilization is porogamous. Syngamy follows triple fusion. The primary endosperm nucleus divides earlier than the fertilized egg. The endosperm is of the Nuclear Type but eventually becomes cellular. Embryogenesis follows the Asterad Type. However many members show no regular pattern of division.

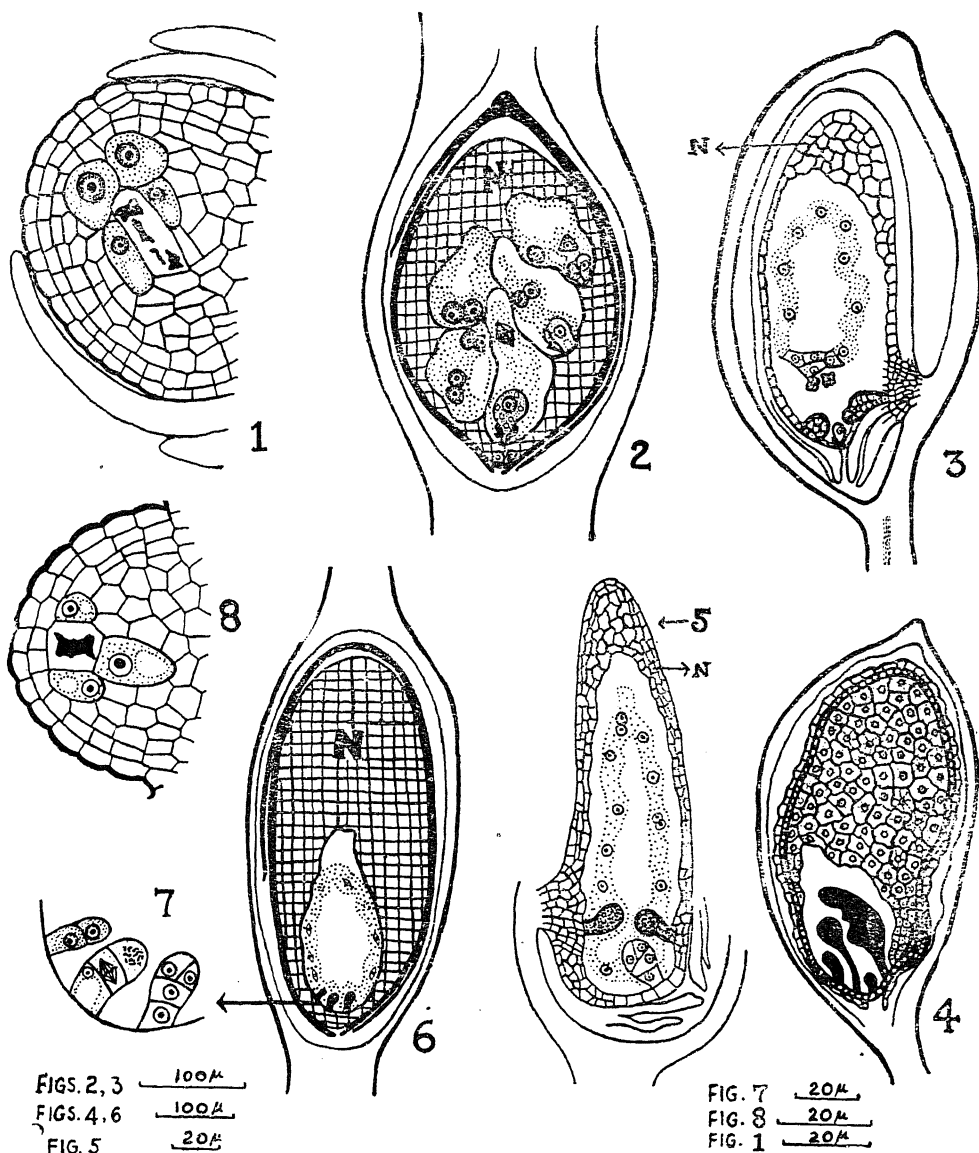
Besides sexual reproduction a few of the grasses described below show varying degrees of deviation. In *Eragrostiella bifaria* (Vahl) Bor nucellar cells near the micropyle enlarge and form additional embryos (Fig. 3). As many as 4 well-developed embryos with suspensors were recorded in 50% of the ovules (Fig. 4). The egg degenerates but at times persists giving rise to a legitimate embryo by fertilization, which grows along with the adventive embryos. One or two of them survive and the rest degenerate.

Collapse of the megasporocyte and its products is occasional in *Iseilema antheophoroides* (Fig. 8). Rarely 2-3 embryos (with indefinite origin) and embryo-sacs derived from nucellar cells are noted (Figs. 6 and 7). *Perotis hordeiformis* Nees shows in addition to the zygotic embryo one or two additional embryos developed occasionally from the nucellar cells (Fig. 5).

Degeneration of the megaspore mother cell and its derivatives of meiosis is common in *Eriochloa procera* (Retz) Hubb (Fig. 1). Two to five nucellar cells around the degenerating megaspore and its products enlarge and show vacuolization. They undergo two or more divisions giving rise to supernumerary embryo-sacs. Most of these embryo-sacs are 4-nucleate but some of them are imperfect and non-functional. They are pushed up to the place of the normal embryo-sac and show rarely the possibility of fertilization. Embryos are noted at

regions other than the micropyle also. In most members of the tribe Paniceae two or more cells of the nucellar epidermis and its wall layers below the micropyle enlarge and show vacuolization. In *Digitaria biformis* Willd and

*Alleteropsis cimicina* (L.) Stapf they even undergo 1 or 2 divisions and seem to show a tendency to take up the function of the haploid embryo-sac in case the latter fails. But they ultimately degenerate.



FIGS. 1-8. Figs. 1-2. *Eriochloa procer.* Fig. 1. Degeneration of the linear tetrad of megaspores and four enlarged nucellar cells. Fig. 2. L.s. of the ovule showing 5 embryo-sacs. Figs. 3-4. *Eragrostiella bifaria.* Fig. 3. L.s. of the ovule showing unfertilized egg and 2 adventive embryos. Fig. 4. L.s. of the fruit showing four embryos with suspensors of which two are well developed. Fig. 5. *Perotis hordeiiformis.* L.s. of the ovule with zygotic and two nucellar embryos. Figs. 6-8. *Iscilema.* Figs. 6 and 7. L.s. of the ovule showing three pro-embryos. Fig. 8. Collapsing macrospore with three enlarging nucellar cells. N, Nucellus.

The tribes Paniceæ and Eragrostæ differ in the position of their antipodals, the presence or absence of division of nucellar epidermis, development of the integuments and presence

We wish to express our deep sense of gratitude to Dr. N. L. Bor and to The Director, Royal Botanic Gardens, for kindly identifying most of the grasses studied here.

TABLE I

Name	Antipodals		Nucellar epidermis divides (D) or not (N)	Outer integument complete (C) or incomplete (I)	Enlarged cells below micropyle present (P) or absent (A)	Any deviations from normal development
	No.	Chalazal (C) or Lateral (L.)				
SUBFAMILY : PANICOIDEAE						
Tribe : Paniceæ						
<i>Eriochloa procera</i>	.. 3	C	D	I	P	2-4 Embryo-sacs
<i>Trachys muricata</i>	.. 3-8	C	D	I	Rarely P	..
<i>Digitaria biformis</i>	.. 3-6	C	D	I	P	..
<i>Digitaria bicornis</i>	.. 3-6	C	D	I	P	..
<i>Alleteropsis cinctina</i>	.. 3-6	C	D	I	P	..
<i>Brachiaria remota</i>	.. 3-8	C	D	I	Rarely P	3 archesporial cells
Tribe : Andropogoneæ						
<i>Iseilema anthephoroides</i>	3-8	C	D	I	P	More than 1 embryo
<i>Sorghum arundinaceum</i>	More than 10	C	D	I	A	..
SUBFAMILY : POOIDEAE						
Tribe : Eragrostæ						
<i>Eragrostiella bifaria</i>	.. 3-8	..	N	C	A	Adventive poly-embryony
<i>Eragrostis tenuis</i>	.. 3-6	L	N	C	A	..
<i>Eragrostis viscosa</i>	.. 3-6	L	N	C	A	..
<i>Eragrostis diarrhena</i>	.. 3-6	L	N	C	A	..
<i>Eragrostis plumosa</i>	.. 3-6	L	N	C	A	..
<i>Eragrostis coarctata</i>	.. 3-6	L	N	C	A	..
<i>Leptochloa neesii</i>	.. More than 10	L	N	C	A	..
<i>Leptochloa paniceæ</i>	.. More than 10	L	N	C	A	..
<i>Dactyloctenium aegyptium</i>	3-10	L	N	C	A	2 megaspore mother cells
Tribe : Oryzæ						
<i>Oryza latifolia</i>	.. 3	C	N	I	A	..
<i>Leersia hexandra</i>	.. 3-4	C	N	I	P	2 archesporial cells and two 8-nucleate embryo-sacs
Tribe : Perotideæ						
<i>Perotis hordeiformis</i>	.. 3	L	N	C	A	More than 1 embryo

of enlarged cells below the micropyle (Table I). The subfamilies Panicoideæ and Pooideæ differ in the presence or absence of divisions of the nucellar epidermis (Table I).

1. Bor, N. L., *Grasses of Burma, Ceylon, India and Pakistan*, Oxford, 1960.
2. Johansen, D. A., *Plant Embryology*, Mass., 1950.
3. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950.



## LETTERS TO THE EDITOR

### INTERPRETATION OF 5<sup>-</sup> LEVELS IN EVEN-EVEN NUCLEI

In a recent note by one of us<sup>1</sup> 5<sup>-</sup> levels in even-even nuclei were interpreted as possibly belonging to  $\lambda = 5$  modes of collective vibration. The evidence in support of this interpretation consisted of the following:

1. The excitation energy of these levels varied very little with mass number suggesting some sort of core excitation.

2. No 5<sup>-</sup> level was definitively known for  $A < 90$  consistent with the breakdown of collective motion characterised by a given number of nodes when the corresponding wavelength at the nuclear surface becomes comparable with or less than the internucleon distance.

Recently Broek<sup>2</sup> has observed levels in Ni and Zn isotopes and suggests that these may arise from coupling of 2<sup>+</sup> and 3<sup>-</sup> states. In view of this it is interesting to re-examine our table on 5<sup>-</sup> levels and see if a re-interpretation on the lines of Broek is possible.

In Table I are assembled 5<sup>-</sup> levels which have been known with some certainty. Column I indicates the even-even nuclei considered in the present analysis. In columns II, III and V are shown the excitation energies of 2<sup>+</sup>, 3<sup>-</sup> and 5<sup>-</sup> states obtained from various references. Column IV is the sum-energy of 2<sup>+</sup> and 3<sup>-</sup> states designated by  $[E(2^+) + E(3^-)]$ . The last columns, VI and VII, indicate the values of  $AE(3^-)$  and  $AE(5^-)$ , where A is the mass number of that particular nucleus.

Now, if the 5<sup>-</sup> level results from the coupling of (one phonon) 2<sup>+</sup> and 3<sup>-</sup> (octupole) states, then one should expect that,

$$[E(2^+) + E(3^-)] = E(5^-).$$

Further one should observe as a result of angular momentum coupling other states namely 1<sup>-</sup>, 2<sup>-</sup>, 3<sup>-</sup> and 4<sup>-</sup> besides the 5<sup>-</sup> level.

The following conclusions can be drawn from Table I:

Columns IV and V indicate that the expected fit for  $[E(2^+) + E(3^-)]$  and  $E(5^-)$  is not found.

Further only in four cases Cd<sup>108</sup>, Cd<sup>110</sup>, Xe<sup>130</sup> and W<sup>182</sup> the two energies come within a difference of 0.2 Mev. Of these only Xe<sup>130</sup> has the  $E(5^-)$  within the predicted energy limit of  $[E(2^+) + E(3^-)]$  set by Broek.<sup>2</sup>

Column V also shows that the excitation energy  $E(5^-)$  is far less than the sum-energy of 2<sup>+</sup> and 3<sup>-</sup> states. By the way of argument one may suspect the existence of some other groups, different from 5<sup>-</sup> levels, which has excitation energies in the vicinity of  $[E(2^+) + E(3^-)]$ . Thus the 5<sup>-</sup> level has a different excitation mechanism and the possibility of arising from two phonon quintet is less.

The similarities exhibited by the excitation energies of 3<sup>-</sup> and 5<sup>-</sup> levels and the quantities of  $AE(3^-)$  and  $AE(5^-)$  having values 200-300 (within certain limits) with the insensitive character to the closed shells, suggest that the same type of excitation mechanism is involved in both 3<sup>-</sup> and 5<sup>-</sup> states. Then the interpretation of 3<sup>-</sup> states as the octupole vibrations of even-

TABLE I

I Nucleus	II <sup>a</sup> E(2 <sup>+</sup> ) Mev	III <sup>b</sup> E(3 <sup>-</sup> ) Mev	IV E(3 <sup>-</sup> ) + E(2 <sup>+</sup> )	V <sup>c</sup> E(5 <sup>-</sup> ) Mev	VI AE(3 <sup>-</sup> )	VII AE(5 <sup>-</sup> )
Zr <sup>90</sup>	..	2.18	2.2	4.38	2.32	198.0
Cd <sup>108</sup>	..	0.630	2.19	2.82	2.54	236.4
Cd <sup>110</sup>	..	0.656	2.056	2.712	2.92	226.2
Sn <sup>118</sup>	..	1.22	2.28	3.5	2.29	269.0
Sn <sup>120</sup>	..	1.18	2.38	3.56	2.29	285.6
Xe <sup>130</sup>	..	0.528	1.998	2.526	2.34	259.8
W <sup>182</sup>	..	0.100	1.374	1.474	1.62	250.1
Pb <sup>202</sup>	..	0.961	..	..	2.04	..
Pb <sup>206</sup>	..	0.803	2.525	3.328	2.8	220.2
Pb <sup>208</sup>	..	..	2.614	..	3.2	543.8
					3.71	771.8
Po <sup>210</sup>	..	1.181	..	..	2.91	611.0

(a) Strominger, D. and Hollander, J. M., *Decay Schemes*, Berkeley, California, June 1958,

(b) Hansen, O. and Nathan, O., *Nucl. Phys.*, 1963, **42**, 197,

(c) Ramaswamy, M. K., *Curr. Sci.*, 1963, **32**, 63.

even core gives some evidence to our interpretation of  $5^-$  states as due to collective vibrations.

Now turning to the other expectation, we find that so far no quintet of  $1^-$ ,  $2^-$ ,  $3^-$ ,  $4^-$  and  $5^-$  is observed in the level schemes of all the cases considered in the present analysis.

The table also shows that no  $5^-$  level is observed for  $A < 90$  consistent with our proposed systematics for the  $5^-$  levels.

The failure to observe the collective  $5^-$  levels may be attributed to the fact that these levels may be obscured by the transitions in the neighbouring low-lying states.

Thus one can interpret  $5^-$  levels as collective vibrations of  $\lambda = 5$  mode.

Dept. of Physics, S. M. BRAHMAVAR.  
Karnatak University, M. K. RAMASWAMY.  
Dharwar, October 22, 1963.

1. Ramaswamy, M. K., *Curr. Sci.*, 1963, **32**, 63.
2. Broek, H. W., *Phys. Rev.*, 1963, **130**, 1914.

## WEAK MODULARITY AND PERMUTABILITY OF CONGRUENCES IN LATTICES

### 1. WEAK MODULARITY IN LATTICES

It is shown that weak modularity of a semi-discrete lattice  $L$  is equivalent to the following conditions:

- (i) If  $a \propto b \geq c \propto d$  and  $(c, d)$  is a lattice translate of  $(a, b)$ , then  $(a, b)$  is a lattice translate of  $(c, d)$ : ( $\propto$  means covers).
- (ii) Dual of condition (i).
- (iii) If  $a > b \geq c > d$  and  $(c, d)$  is a lattice translate of  $(a, b)$ , then there exists a non-trivial subinterval of  $(a, b)$  which is a lattice translate of  $(c, d)$ .
- (iv) Dual of condition (iii).

It also establishes the existence of a class of weakly modular lattices satisfying identical relations other than (i) the lattice of one element, (ii) the modular lattice, and (iii) the distributive lattice. We term these super-modular lattices. A super-modular lattice of order  $n$  ( $n = \text{an integer} > 3$ ) is a lattice satisfying the following identity and its dual (for all  $n$ -tuples of elements  $y_i$  and an element  $x$ ):  $\prod_{i=1}^n (x + y_i) = x + \sum_{i=1}^n (\prod_{j \neq i} y_j)$ ,  $i$  and  $j$  ranging over the values  $1, 2, \dots, n$ , where  $z_{ij} = y$  when  $i \neq j$  and  $z_{ii} = (x + y)$ .

It is easily seen that a super-modular lattice of order  $n$  is a super-modular lattice of every

lower order, and any super-modular lattice is modular and hence is weakly modular.

### 2. PERMUTABILITY OF CONGRUENCES IN LATTICES

The following conditions on a lattice  $L$  are equivalent:

- (1) The two congruences  $\theta$  and  $\phi$  on  $L$  permute.
- (2) For every comparable pair of elements  $(a, c)$ ,  $a \theta b$ ,  $b \phi c$  imply the existence of a  $d$  in  $L$  with  $a \phi d$ ,  $d \theta c$ .
- (3) For all triplets  $(a, b, c)$  forming a chain in that order,  $a \theta b$ ,  $b \phi c$  imply the existence of a  $d$  in  $L$  with  $a \phi d$ ,  $d \theta c$ .
- (4) For all triplets  $(a, b, c)$  forming a chain in that order,  $a \theta b$ ,  $b \phi c$  imply the existence of a  $d$  in  $L$  forming a chain  $(a, d, c)$  in that order with  $a \phi d$ ,  $d \theta c$ .

As corollaries to this we get: (1) Any two  $p$ -neutral congruences on a lattice permute (A congruence  $\theta$  on a lattice  $L$  is called a  $p$ -neutral congruence if and only if  $x \theta y$  implies the existence of a  $t$  with  $t \theta o$  such that  $x + t = y + t$ ). As particular cases of this we get: (i) any two standard congruences on a lattice permute, (ii) any two congruences of a weakly complemented lattice permute, and (iii) any two congruences of a relatively complemented lattice permute.

Further making use of the alternative definition of permutability of congruences arrived at in the theorem, we have

1. Any two congruences on a distributive lattice  $L$  permute if and only if  $L$  is relatively complemented.
2. Any two congruences on a discrete modular lattice  $L$  permute if and only if  $L$  satisfies the condition ( $\alpha$ ): for all  $a, b, c$  in  $L$  with  $a \propto b \propto c$  ( $\propto$  means covers) either  $(a, b)$  is projective with  $(b, c)$  or  $b$  has a complement  $d$  in  $(a, c)$ .
3. Any two congruences on a semi-discrete weakly modular lattice  $L$  permute if and only if  $L$  satisfies condition ( $\beta$ ): for all  $a, b, c$  in  $L$  with  $a \propto b > c$  either  $(a, b)$  is a lattice translate of  $(b, c)$  or  $b$  has a complement  $d$  in  $(a, c)$ .

Detailed proofs will be given in a subsequent paper.

Mathematics Department,  
University of Madras,  
November 4, 1963.

IQBALUNNISA.

# KOJIC ACID AS AN ANALYTICAL REAGENT: SPOT DETECTION OF VANADIUM (V)

SULPHOSALICYLIC ACID<sup>1</sup> and acetylacetone<sup>2</sup> have been reported as very sensitive reagents for the detection of vanadium (V). A new procedure is now developed in which Kojic acid (5-hydroxy-2-hydroxymethyl-4-pyrone) is used for the detection of vanadium (V). Kojic acid is known to react with iron,<sup>3</sup> uranium,<sup>4</sup> copper, cobalt, nickel, manganese,<sup>5</sup> etc., giving coloured products. The advantages of the present test are that the colour is quite stable and that only tungsten and E.D.T.A. among the many substances studied for their interference are found to interfere.

In a concentrated mineral acid medium, vanadium (V) reacts with Kojic acid giving a pink soluble product. The pink colour, however, is very unstable, thus precluding this colour reaction to be of any analytical use. It is observed that a faint red-brown colour is developed at pH 1-2, when vanadium (V) is added to Kojic acid which intensifies in the presence of an alcohol. If the alcohol is immiscible with water, the red-brown complex is extracted into the alcoholic layer on thorough shaking, imparting to it a deep red-brown colour, which is stable for several days. Vanadium (IV) does not give any characteristic colour reaction with Kojic acid under these conditions.

**Reagents.**—(1) Sodium acetate-hydrochloric acid buffer of pH 1.42. (2) 0.2 M aqueous solution of Kojic acid. (3) Benzyl or *n*-butyl alcohol. (4) Test solution prepared by dissolving ammonium vanadate in water.

To 0.15 ml. of buffer solution in a microtest tube, 0.05 ml. of the test solution, 0.05 ml. of Kojic acid solution and 0.25 ml. of alcohol are added and the contents thoroughly shaken. A red-brown colour, appearing in the organic layer, indicates the presence of vanadium.

The limit of identification is found to be 0.5 µg. of vanadium and the dilution limit is 1: 5,00,000.

## INTERFERENCES

Al<sup>3+</sup>, Ba<sup>2+</sup>, Be<sup>2+</sup>, Bi<sup>3+</sup>, Cd<sup>2+</sup>, Ce<sup>4+</sup>, Cr<sup>2+</sup>, Cu<sup>2+</sup>, Co<sup>2+</sup>, Fe<sup>3+</sup>, Pb<sup>2+</sup>, Mn<sup>2+</sup>, Mg<sup>2+</sup>, Hg<sup>2+</sup>, Mo<sup>6+</sup>, Ni<sup>2+</sup>, Th<sup>4+</sup>, UO<sub>2</sub><sup>2+</sup> and Zn<sup>2+</sup> do not interfere with the detection of vanadium (V). Though some of them give coloured products, they are not extracted into the alcoholic layer like the vanadium (V) complex. W<sup>6+</sup> inhibits the colour formation. Citrate, fluoride, phosphate, tartrate have no effect on the colour reaction, while E.D.T.A.

markedly inhibits the colour development. Oxalate also at more than 100-fold concentration inhibits the production of red-brown colour. The detection of alcohols using vanadium (V)-Kojic acid complex is found to be not very sensitive.

It has been possible to determine photometrically vanadium (V) after extraction into alcohol. The details of this investigation are being published separately.

Two of us (D. S. N. and N. K.) are thankful to the Council of Scientific and Industrial Research (India) for the award of Research Scholarships.

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## BIS-TETRAMETHYL AMMONIUM TETRACHLORO MANGANESE (II) COMPLEX

THE stereochemistry expected from ligand field theory for complexes of metals belonging to the first transition series has been worked out.<sup>1</sup> Since *d*<sub>0</sub>, *d*<sub>5</sub> and *d*<sub>10</sub> configurations represent spherically symmetrical non-bonding shells being empty, half-full and full respectively, they are expected to cause the least perturbation to the preferred stereochemistry.

Typical complexes containing *d*<sub>5</sub> non-bonding shell are those of chromium (+ 1), manganese (+ 2) and iron (+ 3) cations. In this communication, a divalent manganese complex has been reported.

Saturated solution (10 ml.) of manganous chloride in absolute alcohol was treated with tetramethyl ammonium chloride (1 g.) in absolute alcohol (10 ml.) and stirred well. The pink solution immediately became colourless and a white precipitate separated out. This was filtered off, washed well with absolute alcohol and dried in a vacuum desiccator (Found % Mn, 16.60; % Cl, 41.21; C<sub>8</sub>H<sub>24</sub>N<sub>2</sub>Cl<sub>4</sub> Mn requires Mn, 15.93; Cl, 41.12). The compound was highly soluble in water and decomposed at

280° C. Conductance measurements revealed it to be a 2:1 electrolyte. The compound is paramagnetic in powder form indicating 5 unpaired electrons ( $\mu_{\text{eff.}} = 5.88$  B.M.).

Many spin-free hexaco-ordinated complexes have been reported earlier.<sup>2</sup> Hexapyridine manganese (II) bromide ( $\mu_{\text{eff.}} = 6.00$  B.M.) potassium bis oxalato diaquo manganate (II) ( $\mu_{\text{eff.}} = 5.69$  B.M.). From ligand field theory, the tetrahedral arrangement is expected to occur less frequently than the octahedral, since the crystal field stabilisation energy is always larger in the latter case. However, recently a tetrahedral compound having the formula  $(\text{Ph}_3\text{MeAs})_2(\text{MnCl}_4)$  has been prepared.<sup>3</sup> The magnetic moment of the compound reported presently is 5.88 B.M. and it is yet another example of a 4 co-ordinated, spin-free, tetrahedral complex of Mn (II).

Thanks are due to Jnan Vijnan Parishad, Utkal University, Bhubaneswar, for a grant.

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#### A SIMPLE TECHNIQUE FOR RECORDING SALIVARY SECRETION BY INCHLEY'S DROP RECORDER

SALIVARY secretion is usually recorded with drop recorders like the Condon's, the Inchley's, drop timer, or with two tambours. Their main disadvantage is the viscid saliva sticking on to the recorders. Moreover, if the interval between the successive drops is long, the saliva dries up blocking up the recorder, necessitating frequent disturbance of the experimental set-up for clearing and cleaning. This was overcome by adopting a water displacement technique with a drop recording assembly.<sup>1</sup> A simple modification, without the electronic device, has been used for recording the salivary secretion from the Wharton's duct of the submaxillary gland of the dogs, in my experiments while studying the effect of antispasmodics.

The technique is as follows. The saliva from the salivary cannula in the duct runs by gravity into a water-filled bottle, with a two-way cork fitted up with the glass and rubber tube connections and placed at a lower level. The saliva displaces an equal volume of the

water from the bottle, which falls out in drops on the Inchley's drop recorder connected to a recording tambour. The size of the bottle can be selected according to the approximate volume of saliva secreted in any single sitting. Combined with a simultaneous time recording, the augmentation in the secretion is indicated by shorter intervals between the vertical lines

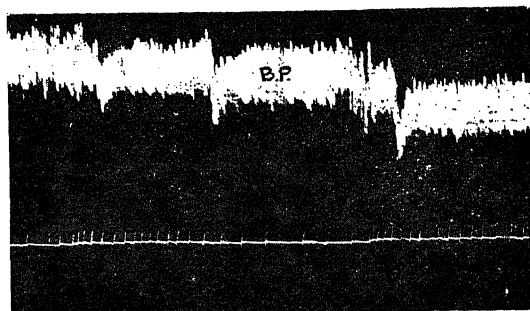


FIG. 1

(vide the tracing); whilst the interval is shown by the height of the vertical curves in Bulbring and Dawes (1945) method. This technique works especially well in experiments running for long durations, obviating the need for frequent cleaning of the drying viscid saliva, as the saliva does not come in direct contact with the Inchley's drop recorder.

My grateful thanks are due to Prof. M. Y. Ansari for guidance.

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#### OBSERVATIONS ON THE ACTION OF BRETILIUM TOSYLATE AND ADENOSINE TRIPHOSPHATE ON THE ISOLATED FROG HEART

*Bretylium tosylate* (Darenthin) has assumed appreciable pharmacological and therapeutic importance in recent years due to its interference in the adrenergic transmission<sup>1-4</sup> and utility in the treatment of hypertension and peripheral vascular diseases.<sup>5-6</sup> As the mechanism of its action is not yet fully known, the relationship of Darenthin with adenosine triphosphate (ATP) has been studied.

The experiments have been carried out on isolated frog hearts and responses to graded doses of Darenthin recorded before, during and

after perfusion with ATP (2.5-10  $\mu\text{g./ml.}$ ). Similarly, in another series of experiments, effects of graded doses of ATP have been studied during perfusion with Darenthin (5-10  $\mu\text{g./ml.}$ ).

Darenthin has been found to inhibit the ATP-induced stimulation of frog heart (Fig. 1 and Table I). The inotropic effect of Darenthin was also observed to be blocked by ATP (Fig. 2 and Table II).

TABLE II  
Showing the effect of ATP on stimulant action of Darenthin on frog heart

ATP $\mu\text{g./ml.}$	Percentage stimulation		Inhibition percentage $\pm\text{SD}$
	Control	Perfusion with ATP	
2.5	20	16	$20.0 \pm 1.8$
5.0	16	7	$56.2 \pm 4.9$
10.0	13	5	$61.5 \pm 7.1$

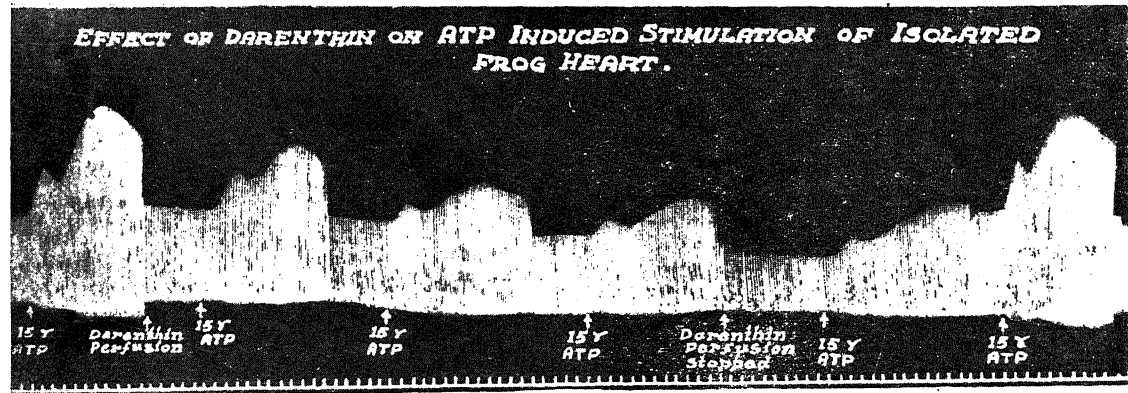


FIG. 1

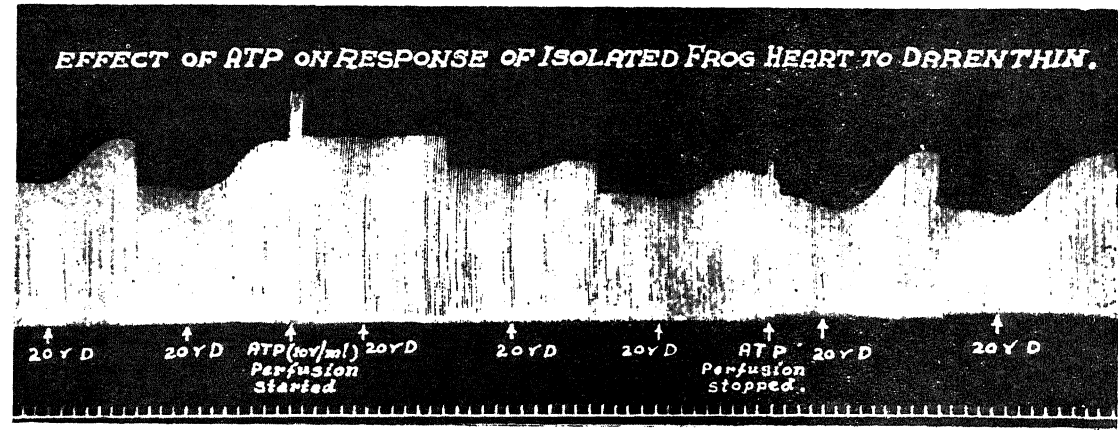


FIG. 2

TABLE I  
Showing the effect of Darenthin on ATP-induced stimulation of frog heart

Darenthin $\mu\text{g./ml.}$	Percentage stimulation		Inhibition percentage $\pm\text{SD}$
	Control	Perfusion with Darenthin	
5.0	67	47	$29.0 \pm 3.1$
7.5	37	22	$42.0 \pm 5.2$
10.0	53	27	$54.0 \pm 5.7$

Darenthin and ATP have been found to block each other's action on the isolated frog heart. As Darenthin prevents the release of catechol amines, which are known to be held in the chromaffin granules, rich in ATP, the above finding seems to be of interest in its mechanism of action.

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### FLAVONOIDS OF THE FLOWERS OF *HIBISCUS MUTABILIS*

IN continuation of our earlier studies on the flavonoids of *Hibiscus tiliaceus*<sup>1</sup> and *Hibiscus surattensis*,<sup>2</sup> we have chemically examined the flowers of *Hibiscus mutabilis*<sup>3,4</sup> known as 'changing rose' whose flowers do not seem to have been systematically investigated earlier, except for a report<sup>5</sup> on the presence of cyanin. The colour of the large and attractive flowers of *H. mutabilis* commonly propagated by cuttings is ivory-white to pale yellow in the morning and pink red in the evening. The fresh flowers of *H. mutabilis* growing in a Pondicherry garden collected before eight in the morning have been found to contain quercimeritrin (quercetin-7-glucoside) with a small proportion of meratin (quercetin-3-diglucoside) and those after four in the evening contain cyanin (cyanidin-3,5-diglucoside) and practically no anthoxanthin.

The fresh morning (pale yellow) flowers were extracted with sufficient methanol by cold maceration three times, each time lasting for twelve hours and the combined extract concentrated *in vacuo* to remove all methanol. The aqueous layer was shaken with petroleum ether to remove waxy matter (no carotenoid pigments present) and then with ether to get the free anthoxanthin components. The residue from the ether layer was found to contain only quercetin, the identity of which was established by comparison with an authentic sample of the compound. The aqueous layer after extraction with ether on paper chromatography gave indication for the presence of two glycosides which could be purified by large-scale paper chromatography using *n*-butanol-acetic acid-water (4:1:5 v/v, upper phase). They were then separated by rechromatography on paper with water as the solvent; one of them was identified as quercimeritrin, R<sub>f</sub> (ascending) 0.52 (phenol-water, lower), 0.72 (*n*-butanol-acetic

acid-water, 4:1:5, upper), 0.73 (acetic acid-water, 6:4) and the other as meretin<sup>6</sup> 0.56 (acetic acid-water, 15:85), 0.75 (acetic acid-water, 6:4), 0.37 (water), the R<sub>f</sub> values agreeing with those reported earlier. The identity of quercimeritrin was also confirmed by comparison and co-chromatography with an authentic specimen from *Gossypium hirsutum*.<sup>7</sup> The aqueous layer containing the mixture of glycosides on acid hydrolysis yielded a single aglycone, quercetin and glucose only as the sugar. The total yield of the pigments was about 0.08%.

Fresh evening (pink-red) flowers from the same plant were extracted in the cold with sufficient methanolic hydrochloric acid (0.1N HCl) and the anthocyanin worked out according to an earlier method.<sup>8</sup> From the R<sub>f</sub> values, colour reactions, absorption ( $\lambda_{\text{max}}$ , 523 m $\mu$  MeOH-HCl) of the pigment, the single anthocyanin pigment present was identified as cyanin which confirmed the earlier report<sup>4</sup> of its presence in these flowers. Identity of cyanin was further established by acid hydrolysis (1 N HCl) when cyanidin<sup>9</sup> (compared with an authentic sample) and glucose were obtained.

It is interesting to note that in the flowers of *H. mutabilis* no oxidation or reduction compound of the basic anthoxanthin quercetin is found unlike in other *Hibiscus* species which have been earlier reported<sup>1,2,10,11</sup> to contain gossypetin and hibiscetin derivatives (along with quercetin).

The absence of anthocyanin type of pigment in the morning and any significant amount of anthoxanthin in the evening flowers needs a precise explanation from the point of view of biosynthesis of flavonoids in these flowers. It may also be mentioned here that the co-occurrence of flavonol glycosides and their corresponding anthocyanins have been established in a number of plants, most studied examples being the cultivated potato, *Lathyrus*, *Plumbago* and *Rhododendron* species.<sup>12</sup> In this connection, the recent report by Seshadri *et al.*<sup>13</sup> on the preparation of anthocyanidins and their glycosides from their related flavonoids is interesting.

We thank Professor T. R. Seshadri for his kind interest in this work and Dr. S. G. Veng-sarkar for constant encouragement.

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#### A RAPID TEST FOR DETERMINING NICOTINE IN GREEN TOBACCO LEAF

A RAPID test for determining nicotine in green tobacco leaf is much sought for while classifying flue-cured tobacco plants in the field on the basis of their alkaloid content, especially in the breeding programme.

After studying different techniques<sup>1-3</sup> a simple method has been developed incorporating suitable modifications in Raffauf's field test procedure and in the quick laboratory procedure of the U.S. Department of Agriculture, reported by Lomakina.<sup>4</sup>

**Test Reagent.**—A solution of 0.85 g. of bismuth subnitrate in 10 ml. of glacial acetic acid and 40 ml. of distilled water is mixed with a solution containing 8 g. of potassium iodide in 20 ml. of distilled water and stored in a brown bottle.

**Colour-intensifier.**—10% citric acid solution.

**Field Test.**—About 1 g. of green leaf tissue is ground in a glass mortar with some glass wool and the pulp pressed through a dry muslin cloth to collect the juice into a small clean porcelain dish. 20  $\mu$  of this juice is drawn by means of a micropipette and spotted on a Whatman No. 1 filter-paper strip, allowed to dry and treated with 20  $\mu$ l. of the test reagent. An orange spot on a pale yellow background indicates the presence of nicotine. The spot is treated after drying, with 40  $\mu$ l. of the colour-intensifier whereby the central spot turns red. As the concentration of nicotine increases the

depth of the red colour also increases, denoting roughly the concentration of the alkaloid. Comparison with the colour intensity of the spots developed with a range of known nicotine concentrations as standards will be very helpful in evaluating the approximate nicotine content in the test sample.

**Laboratory Test.**—Whatman No. 1 filter-paper is cut into strips of 15  $\times$  180 mm. dimensions (with a 2 cm. portion at one end cut into a tail), treated with 0.2 M KCl solution and dried at room temperature. The juice, prepared as under 'Field test', is centrifuged at 2,000 r.p.m. for 2 minutes and 20  $\mu$ l. of the centrifugate is spotted on the strip, 2 cm. from the tailend, and air-dried. An ascending type of chromatogram is run in a suitable chamber using *n*-butanol, hydrochloric acid (Sp. gr. 1.19) and water in the proportion of 100:40:13 (V/V) as solvent. The solvent ascends to about 7 cm. in 100 minutes at the room temperature varying between 32–36°C. The strips are dried and dipped in the test reagent to obtain clear red spots of nicotine on a yellow background.

In a test experiment run with a series of dilutions of the original extract (prepared from the left half of the *N. tabacum* leaf) having 1.00, 0.75, 0.50 and 0.25 of the original concentration, the chromatograms were run as above and their spot areas and *R<sub>f</sub>* values determined (Table I). Nicotine was determined from the right half by the method of Griffith and Jeffrey.<sup>5</sup>

TABLE I  
Spot areas and *R<sub>f</sub>* values for the corresponding nicotine concentrations

Percentage nicotine on O.D. basis	1.4900	1.1175	0.7450	0.3725
Spot area (sq. mm.)	132	117	89	50
<i>R<sub>f</sub></i> value	.. 0.53	0.57	0.59	0.61

It is seen from Table I that the *R<sub>f</sub>* value increased with a decrease in the alkaloid concentration. Spot area showed a consistent decrease with decrease in the nicotine level (Fig. 1). By plotting the spot area against the logarithm of the nicotine concentration a linear relationship (Fig. 2) was obtained. (Incidentally, it was found that the correlation coefficient was +0.999\* for these values.) A similar linear relation was reported by Fisher *et al.*<sup>6</sup> for amino-acids and sugars. It is possible, therefore, to obtain a linear regression of nicotine content of the leaf on the spot area which will be fairly satisfactory to estimate well within experimental error the nicotine content of a given sample of tobacco.

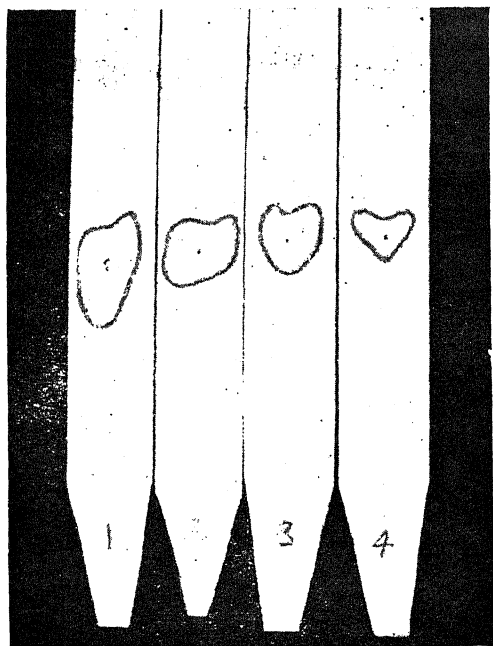


FIG. 1. Spot-area decreasing with decreasing nicotine content.

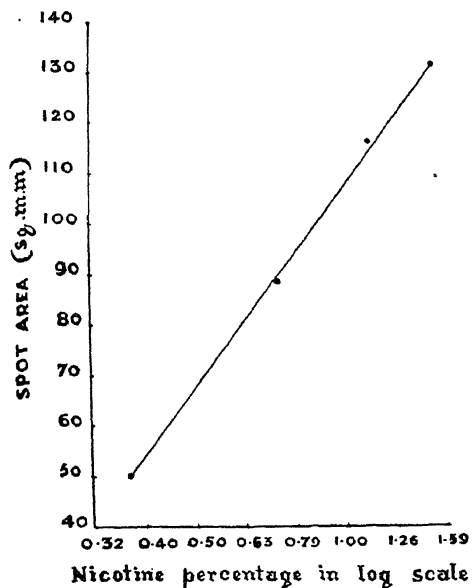


FIG. 2. Relationship of spot-area to logarithm of nicotine content.

The advantage of this method lies in the fact that the test can be conducted directly on the green leaf and the time taken is only a few minutes for the field test and less than 2 hours for the laboratory test. The latter test is quite sensitive and an absolute amount as low as 13 µg.

of nicotine can be detected and quantitatively determined by this procedure simultaneously on a number of samples. The test is negative for anabasine but it does not distinguish between nicotine and nor-nicotine.

Thanks are due to Dr. G. S. Murty for his kind interest in the work and to Sri. M. V. Pavate for statistical help.

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#### ALKALINE PHOSPHATASE IN THE NEPHRIDIAL BLADDER OF THE INDIAN LEECH *HIRUDINARIA GRANULOSA* (SAVIGNY)

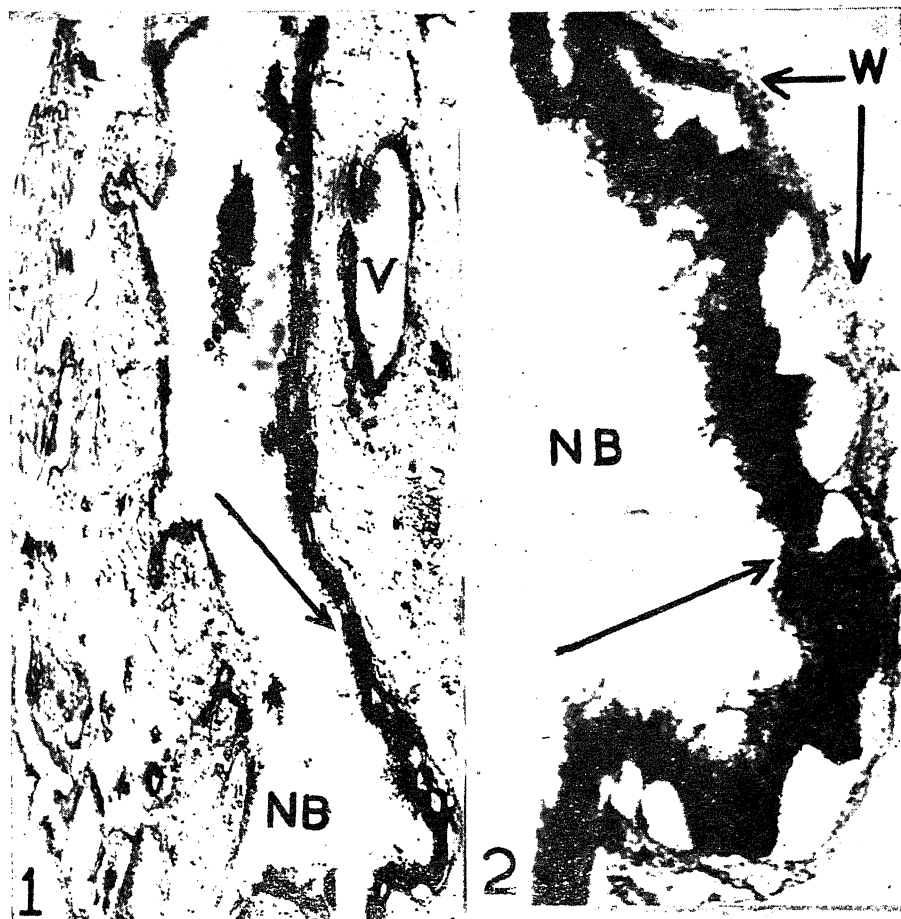
THE nephridial bladders of *Hirudinaria granulosa* and *Hirudo medicinalis* are lined internally by a thick felt-like layer of bacteria,<sup>1,2</sup> which have been confused with cilia.<sup>3</sup> The present experiments have helped to distinguish the wall of the nephridial bladder of *Hirudinaria granulosa* from the so-called 'cilia' (bacteria) on the basis of the distribution of alkaline phosphatase.

Thoroughly fed leeches were quickly dissected alive. The nephridial bladder was carefully removed with the vesicle-duct intact and was fixed either in 80% ethyl alcohol or in chilled absolute acetone. After dehydration and embedding in paraffin, sections were cut at 10 µ and stained with the Gomori's revised Ca-CoS method for the histochemical demonstration of alkaline phosphatase.<sup>4</sup> Controls were set up in an identical manner but with the glycerophosphate omitted.

The enzymatic activity was mainly localized in the bacterial layer. The wall of the nephridial bladder and the vesicle-duct gave a negative response to the enzyme (Figs. 1, 2).

Previously alkaline phosphatase has been histochemically demonstrated in a variety of bacteria<sup>5,6</sup> by the Gomori's technique. It has been suggested that the phosphatases are concerned with the removal of phosphate from phosphorylated hexoses and consequently their conversion to sugar residues for cellular





FIGS. 1-2. Fig. 1 T.s. of the nephridial bladder (NB) of *Hirudinaria granulosa* showing an intense positive reaction for alkaline phosphatase in the bacterial layer (arrow). The vesicle-duct (V) is devoid of such layer,  $\times 360$ . Fig. 2. A portion of Fig. 1 highly magnified, showing a negative reaction for the enzyme in the wall (w, arrows) of the nephridial bladder. The bacterial layer shows an intense reaction (arrow),  $\times 1,620$ .

metabolism in bacteria.<sup>7</sup> The present results suggest that such a function is probably taking place in the bacterial lining of the nephridial vesicles. It is of interest to mention that certain nutrient substances, which leak out during the process of excretion from the nephridium proper, promote a very rich growth of the bacteria in the vesicle.<sup>1</sup> Intense positive histochemical reaction for alkaline phosphatase in the bacteria is of considerable interest in this context.

The author is indebted to Dr. H. B. Tewari for guidance.

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**ENCHODELUS MACRODOROIDES**  
(STEINER, 1914) THORNE, 1939  
(NEMATODA: DORYLAIMOIDEA)

A SINGLE female specimen belonging to the genus *Enchodelus* Thorne, 1939, was found in soil collected from around the roots of pine trees, *Pinus* sp., in Simla (H.P.) North India. This is the first record of this genus from India. Since chlorophyll-like material is found in the intestinal contents of the nematodes belonging to this genus,<sup>1</sup> it is obvious that they feed entirely on plants they infest. However, experimental evidence is not available. The present material closely agrees with the description of *Enchodelus macrodoroides* as provided by Thorne<sup>1</sup> (1939) but differs from it in some features which are slight intraspecific variations. Measurements and a brief description are provided here. The description in parenthesis is according to Thorne given for comparison with the present material.

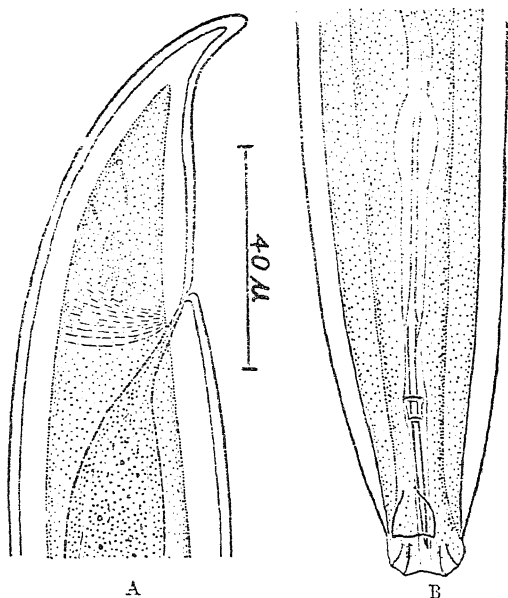


FIG. 1. A. Anterior end. B. Posterior end.

L = 1.7 mm.; a = 33; b = 5.3; c = 31; V = 50; Spear = 40  $\mu$ ; Spear extension = 37  $\mu$ .

Body cylindrical, tapering to both extremities and ventrally arcuate when relaxed. Cuticle smooth, 3  $\mu$  thick, subcuticle finely striated. Lip region amalgamated, slightly marked off from the body contour by a constriction. Amphidial apertures about half as wide as head. Spear  $3\frac{1}{2}$  times the width of lip region ( $2\frac{1}{2}$  times) with minute aperture. Spear extension with well-developed flanges. Guiding ring double. Esophagus slender

anteriorly in about  $\frac{2}{3}$ rd of its length, then enlarges gradually to form the basal expanded portion. Cardia obscure. Prerectum  $1\frac{1}{2}$  anal body diameter (4-5 times); rectum about one anal body width (almost as long as tail). Vulva a transverse slit, equatorial (V = 48). Ovaries symmetrical, amphidelphic and outstretched (reflexed  $\frac{1}{2}$ - $\frac{2}{3}$ rd the distance back to vulva). A pair of caudal papillae present. Tail ventrally arcuate, about twice the anal body diameter.

Dept. of Zoology, M. SHAMIM JAIRAJPURI.  
Aligarh Muslim Univ., ATHER H. SIDDIQI.  
Aligarh (U.P.), India, June 26, 1963.

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**SUPERNUMERARY ARCHESPORIAL  
CELL IN *OCHNA ATROPURPUREA* DC.**

The genus *Ochna* consists of twenty-five species (Hooker, 1835) distributed in Tropical Asia and Africa. In Bengal, there are found only two species (Prain, 1905). The present investigation has been made on *Ochna atropurpurea*, which is often cultivated in gardens. The contribution towards the knowledge of embryology in the family Ochnaceae is still very fragmentary. Schnarf (1931) has briefly reviewed the earlier literature on the embryology of a few species of *Ochna*. Recently, Chikkanniah (1954) has published a brief note on the development of the female gametophyte in *Ochna squarrosa* Linn.

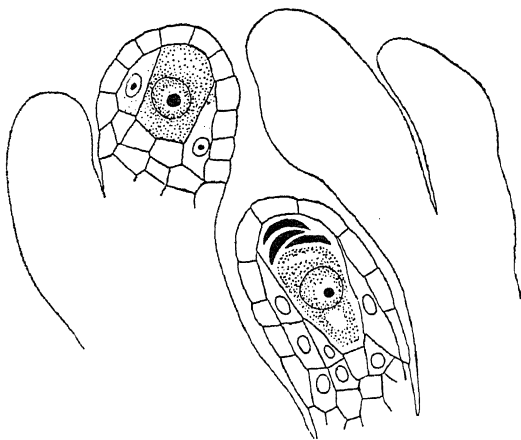


FIG. 1. L.S. of an ovule showing a supernumerary archesporial cell in the inner integument,  $\times 1,050$ .

The ovule is anatropous, bitegmic and tenuinucellate. The megaspore mother cell gives rise to a linear tetrad in the usual way. The chalazal megaspore becomes invariably functional (Fig. 1). The development of the female

gametophyte conforms to that of *O. squarrosa* as noted by Chikkanniah (1954). During embryological investigation on this species, a peculiar structure has been met with in the ovule. It has been observed by the present author that the supernumerary archesporial cells develop in 10-15% of the ovules. Figure 1 shows the functional megaspore with three degenerated megaspores in the micropylar region and the inner integument manifests the presence of an enlarged archesporial cell. The cytoplasm of the same shows dense chromaticity and stainability. It is also clear from Fig. 1 that the two integuments are fused in the lower region. The presence of two archesporial cells in an ovule indicates possible occurrence of polyembryony in the species investigated.

A detailed account of the embryological studies will soon be published elsewhere.

The author is indebted to Dr. S. M. Sircar, for his valuable guidance, Dr. I. Banerji for suggesting this problem and to Dr. K. Basu, Principal, for providing necessary facilities.

Dept. of Botany, RASH BEHARI GHOSH.  
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Calcutta-29, August 6, 1963.

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#### GERMINATION OF POLLEN GRAINS IN *NELUMBIUM SPECIOSUM* WILLD.

AN interesting deviation from the normal type of germination of pollen grains, characteristic of most of the angiosperms, has been observed in *Nelumbium speciosum* Willd. The pollen grains are tricolpate, and subprolate measuring about 80  $\mu$  in diameter.

During the process of germination the grain swells and the spore contents escape out of the grain by rupturing the exine but still enclosed in the intine. The intine enclosing the spore contents shows differentiation into an outer ectintine and an inner endintine (Fig. 1). A little later the intine shows a small protrusion which develops into the pollen tube (Fig. 2).

Such a type of germination of pollen grains is remarkable having been reported so far only in *Illicium floridanum*<sup>1</sup> where the exine splits completely into three separate sections which are cast off. Therefore, it has been considered worthwhile to record the same here.

Our thanks are due to Professor G. Erdtman for a personal communication confirming that

the above phenomenon is unusual in the angiosperms.



FIGS. 1-2. Fig. 1. Germination of the pollen grain casting off the exine. Note the spore contents enclosed in the intine showing differentiation into ectintine and endintine. Fig. 2. The same showing the developing pollen tube.

Department of Botany, J. VENKATESWARLU.  
Andhra University, V. SESHAVATARAM.  
Waltair, July 16, 1963.

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#### ON A FOSSIL BRYOPHYTIC SPOROGLONIUM FROM THE DECCAN INTERTRAPPEAN BEDS

Our knowledge of fossil bryophytic sporogonia from India is rather meagre. Saksena (1958) has described a young moss sporophyte *Capsulites gondwanensis* from the South Rewa, Gondwana basin. Gupta (1956) has recorded *Notothylas* type of sporogonium from the Deccan Intertrappean beds.

In view of the rare occurrence of fossil bryophytes and especially their sporogonia, the

discovery of a well-preserved petrified specimen in a black chert from the Deccan Intertrappean beds of Mohgaon-Kalan, District Chhindwara (M.P.), is well worthy of record. A number of serial peel sections were prepared and studied.

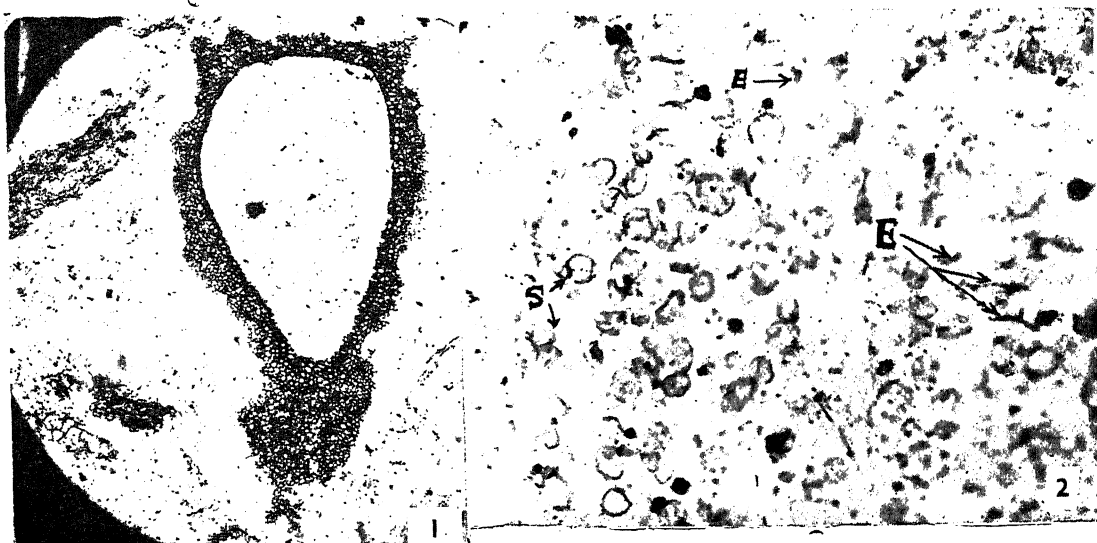
The sporogonium is surrounded on all sides by certain tissues, but especially the tissues at the base are in organic connection with the sporogonium and may belong to the tissues of the thallus in which it is embedded (Fig. 1). The sporogonium consists of the capsule and the foot. In between the capsule and the foot, there is a slight constriction which may represent the seta; otherwise there is no other indication of its existence. The sporogonium measures on an average  $1.5 \times 0.75$  mm. The capsule is more or less spherical or elongated and measures about  $1.1 \times 0.55$  mm. The wall of the capsule is 1 to 3-layered thick and is devoid of stomata. The cavity of the capsule contains spores and elaters (Pseudoelaters).

The foot is bulbous, flattened and round or slightly elongated. The length of the foot varies from 0.2 to 0.33 mm.

The dehiscence of the sporogonium is not seen. However, there is the probability that the sporogonium might have been dehiscent by the decay of the capsule wall as in the family Ricciaceae.

The spherical shape of the capsule more or less resembles the shape of the capsules of certain members of the family Marchantiaceae as in *Dumortiera*, *Fimbriaria*. The affinities of the present material, in its probable mode of dehiscence by the decay of the wall of sporogonium, can also be traced to the family Ricciaceae.

Further, the present specimen shows affinities with Anthocerotales in characters as (a) presence of simple, occasionally branched elaters; (b) a well-developed bulbous foot, (c) absence of columella as in certain species of *Notothylas* and (d) spores mostly round



FIGS. 1-2. Fig. 1. Bryophytic sporogonium *Shuklanites deccanensis* Gen. et sp. nov. showing the capsule and the foot. The capsule cavity contains spores and elaters,  $\times 50$ . Fig. 2. A part of the sporogonium magnified showing the spores (S) and elaters (E),  $\times 454$ .

Within the capsule no columella or sterile tissue is seen (Fig. 1).

The spores are smooth, transparent, yellow, thin-walled, may be round, oval or triangular in shape and possess a distinct triradiate mark showing tetrahedral development (Fig. 2 S). On the average the spore measures  $0.011 \times 0.009$  mm. The elaters are thin-walled, transparent, brown in colour, simple or occasionally branched and no spiral thickening is seen (Fig. 2, E). On the average the elater measures from 0.01 mm. to 0.04 mm. in length and 0.0022 mm. in breadth.

with a smooth and thin outer margin (Campbell, 1928; Kashyap, 1929).

Thus the present specimen combines certain features of Marchantiales and certain others of Anthocerotales. But the characters of the specimen described above weigh very much with the characters of Anthocerotales.

The bryophytic sporogonium described by Gupta (1956) from the same locality, as the present one, differs from the above-described sporogonium not only in size and shape but also in the absence of distinct spores and elaters. Moreover, this bryophytic sporogonium

is further characterized by the possession of a bulbous and flattened foot.

The present specimen, therefore, retains its individuality on the ground of its form, size of spores and elaters, absence of columella and stomata and other characters. And hence, it may be considered a new genus and has been named *Shuklanites deccanii* Gen. et sp. nov.

The author expresses his deep gratitude to Prof. V. B. Shukla, for his guidance. His thanks are also due to Shri R. C. Agnihotri for facilities and encouragement.

Botany Department,  
College of Science,  
Raipur (M.P.), July 9, 1963.

L. C. SINGHAL

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#### PYTHIUM STALK ROT OF CORN IN INDIA

DURING the monsoon season of 1961 a severe stalk rot of corn was noticed in the experimental crop of the Co-ordinated Maize Breeding Scheme at the Indian Agricultural Research Institute. While certain inbred lines were completely damaged, other varieties standing alongside either remained free from infection or showed the disease only sparingly. The disease had started in 6-8 weeks old plants in the last week of July and continued to be destructive till the end of August. The rotting was confined to a single internode, the second or third one above the soil level. The diseased internodes had become brown, water-soaked, soft, and at this point the plant twisted and toppled over to the ground while still attached to the stalk through the vascular fibres. Such plants continued to remain green for several days. The diseased plants could be detected only after they had fallen to the ground. A fungus which was identified as *Pythium butleri* Subramanian was consistently isolated from the rotted tissues. During August 1962, the disease was successfully reproduced by inoculating young cultures of the fungus on 6-8 weeks old plants of the corn variety Ganga 101. The inoculation was made by introducing two days old PDA Culture into wounds on the basal part of the stem made by means of a cork-borer. About 30 plants were inoculated in this way. All the inoculated plants toppled over to the ground within 4-8 days of the

inoculation. The inoculated internodes showed the typical symptoms of the disease encountered in nature. On reisolation from such diseased internodes, *Pythium butleri* Subramanian was readily obtained in each case. The uninoculated but similarly wounded plants standing side by side remained healthy.



FIG. 1. Corn plants showing stalk rot infection.

It was observed that the infection and development of the disease depended upon the age of the plant; only young plants, before differentiation of abundant fibrous tissues in the stem, took infection when inoculated through the wounds. Unwounded and mature plants failed to take infection. It is interesting to observe that the disease occurred only in the monsoon season of 1961 when there were incessant heavy rains for one month resulting in the water-logging of the standing crop. During the monsoon season of 1962 the rainfall was intermittent and the observations made in the same plots of corn did not reveal the presence of the disease.

Elliott<sup>1</sup> in 1943 published a detailed account of the disease. She reported the causal organism as *Pythium butleri* Subramanian.

According to her the disease was first observed in Virginia, U.S.A., by M. T. Jenkins. Subsequently it was reported from several other places from the U.S.A., viz., Indiana,<sup>2</sup> Kentucky<sup>3</sup> and Illinois.<sup>4</sup> The disease is also reported from Jamaica<sup>5</sup> and Venezuela.<sup>6</sup> The occurrence of this disease is being reported for the first time from this country.

The authors wish to thank Dr. B. L. Chona, Dr. E. W. Sprague and Dr. R. L. Paliwal for their keen interest and help in this investigation.

Division of Mycology and D. N. SRIVASTAVA.  
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Indian Agri. Res. Inst.,  
New Delhi, June 25, 1963.

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### GROWTH OF RECEPTACLE IN CASHEW AS INFLUENCED BY GROWTH SUBSTANCES

CASHEW (*Anacardium occidentale* L.) is an ideal material for studying the effects of nut on growth and development of receptacle because the removal of nut does not cause much injury to the axis. In strawberry Nitsch<sup>1</sup> (1950) observed that achene development is intimately associated with growth of the receptacle. Removal of all the achenes stopped growth of the fleshy part but application of naphthoxyacetic acid and indolebutyric acid effectively replaced fertilized achenes in inducing growth of the receptacle in normal shape.

15 days after opening of flowers nut was detached from the receptacle and growth substances, 2, 4, 5-T (2, 4, 5-trichlorophenoxyacetic acid) 2, 4-D (2, 4-dichlorophenoxyacetic acid) and GA (gibberellic acid) were applied in 100 and 1,000 p.p.m. in lanolin at the cut surface. There were 7 treatments in all including control and 10 replications were used per treatment. At the time of application of growth substances the receptacles were 1.5 cm. in length and 3 mm. in diameter.

The untreated receptacles dried and dropped off in 5-7 days after the nuts were detached, while those treated with 2, 4, 5-T and 2, 4-D in both the concentrations enlarged into fleshy

fruit-like structures. G.A. did not, however, show further development but the receptacle remained attached to plant throughout the period of experiment. Growth substances caused much faster development and early ripening of fleshy receptacle than those on which the nuts remained attached.

The results of this experiment also suggest that growth of receptacle is controlled by hormone supply and the seed is the centre of production.

Agri-Horticultural Society of India,  
Calcutta-27, August 22, 1963.

T. K. BOSE.

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### NEW PLANT RECORDS FROM INDIA

DURING floristic studies in different parts of India including the interior parts of North-East Frontier Agency, a few interesting species were collected and studied. Some of them which are either new or little known to the country are noted below :

#### GESNERIACEÆ

1. *Beccarinda cordifolia* (Anthony) B. L. Burt  
(= *Petrodoxa cordifolia* Anthony).  
Loc.—Takepokong—Sirang (Siang frontier division, N.E.F.A.) 1700-2200 m., Rolla 17882.

This is the first record of the genus and the species in India which are not known so far west of Burma. This is interesting particularly with reference to the distribution of the genus from Upper Burma to Yunnan and other parts of China towards the east and the Himalayan region towards the west.

#### DIOSCOREACEÆ

2. *Dioscorea soortechinii* Prain et Burkill.  
Loc.—Minguing (Siang frontier division, N.E.F.A.) 1200 m., Rolla 17744.

This is so far known from Malayan Peninsula and Sumatra. The present new record in the Himalayas extends its distribution further north possibly through Burma.

#### POACEÆ (= GRAMINEÆ)

3. *Leptaspis porceolata* (Roxb.) R. Br.  
Loc.—Chudal area (Tennmalai forest division, Kerala) 300 m., Rolla 61380; Parappur (Tennmalai forest division, Kerala) 350 m., Subramanian 71512.

An interesting forest grass with broad leaves, so far known from South-East Asia and Ceylon and now seems to have recently migrated to the southernmost part of Kerala through Ceylon.

ORCHIDACEÆ

4. *Coelogyne carnea* Hook.f.

Loc.—Mingung (Siang frontier division, N.E.F.A.) 1200 m., Rolla 17757.

This species, so far known only from Malayan Peninsula, is now recorded from the Himalayan zone. A mention about this locality together with its occurrence also in K. & J. Hills, Assam, was, however, made by Panigrahi.<sup>1</sup>

SANTALACEÆ

5. *Phacellaria compressa* Benth.

Loc.—Mountain slope above Bela village (Apathanang valley, Subansiri frontier division, N.E.F.A.) 1900 m., Rolla 1677.

This was collected in dioecious stage as a complete parasite on *Taxillus vestitus* (Wall.) Danser (Loranthaceæ) which, in turn, is semi-parasitic on *Pyrus pashia* Buch.-Ham. (Rosaceæ).

Of the seven species known so far under the genus which are distributed mostly in the mountainous regions of S.E. Asia, only *P. compressa* on the basis of the present record is considered to have migrated further north into the Himalayan zone. *P. wattii* Hook.f. recorded from Manipur in *Fl. Brit. India*, 1886, 5, 236 is considered in the recent revisions<sup>2,3</sup> of the genus to be a synonym of *P. compressa*. This view further supports the possibility of the migration of the species from S.E. Asia to the Himalayas through the Manipur ranges.

Botanical Survey of India, ROLLA SESHAGIRI RAO.  
Poona-1, July 29, 1963.

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**CURVULARIA TUBERCULATA FROM  
DUNE SOIL**

In the course of a study of dune soil fungi, the author came across *Curvularia tuberculata*, one of the two new species described by Jain (1962),<sup>2</sup> occurring on maize leaves from Udaipur (Rajasthan) and paddy grains from Delhi. The soils were collected during June 1963 from coastal dunes near Chirala (Guntur District, Andhra Pradesh), where *Spinifex littoreus* Merr. and *Ipomœa pes-capræ* Sweet are the two dominant species. The fungi were isolated by soil plate method (Warcup, 1950),<sup>2</sup> employing tomato agar medium. The fungus under study forms a new record for the soil and, therefore, is described below.

Colonies of the fungus spreading rapidly on potato sucrose agar, brown to blackish-brown, woolly, sporulating abundantly; vegetative hyphæ branched, septate, pale brown, smooth,

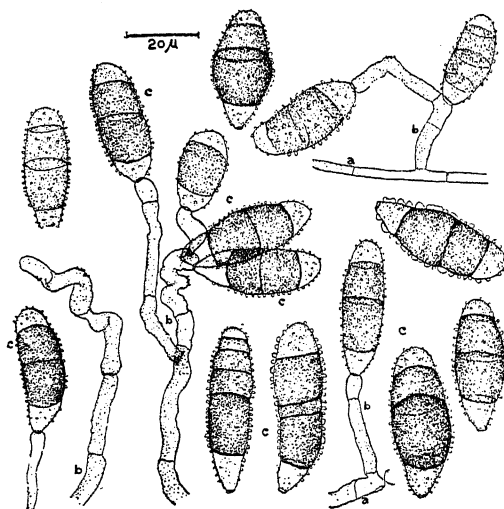


FIG. 1. *Curvularia tuberculata*. a, mycelium; b, conidiophore; c, conidia.

2.5–7.8  $\mu$  wide. Conidiophores simple or branched, slender at the base slightly wider and thick-walled towards apex, brown but paler towards the tip, geniculate, markedly tuberculate at swollen nodes, septate, variable in length, 3.0–5.5  $\mu$  wide. Conidia borne spirally or alternately towards the tip, straight or ellipsoidal, rarely slightly curved, fusiform or cylindrical, 3-septate or very rarely 4- to 5-septate, sometimes constricted at the septa, the septa being thick and dark brown, tuberculate all over the surface, the tubercles being of variable size, brown to dark brown, two middle cells darker and larger, sometimes the second cell from the base of the conidium being the largest and darkest, the apical cell with a broadly rounded tip, paler in colour, the basal cell pale brown, shaped like a crucible, with a distinct scar at the base indicating the point of attachment, 29.5–48.0  $\times$  13.0–19.0  $\mu$ .

The culture will be deposited in Indian Type Culture Collection of Fungi, I.A.R.I., new Delhi.

The author is grateful to Prof. M. R. Suxena for encouragement.

Botany Department,  
Osmania University,  
Hyderabad-7, August 13, 1963.

P. RAMA RAO.

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## REVIEWS

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**The Theory of Superconductivity.** Edited by N. N. Bogoliubov. International Science Review Series 4. (Published by Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), Price \$ 4.95.

The phenomenon of superconductivity which was discovered by Kamerlingh Onnes in 1911 may briefly be summed up by the statement that many metals and alloys, below a certain critical temperature characteristic of the substance, have no measurable electrical resistance. The phenomenon has since then been the subject of numerous experimental researches, and several other interesting features of it have been brought to light. A phenomenological theory of superconductivity was advanced by F. and H. London in 1935, but until 1950 its real nature remained an enigma. Since 1950, however, there has been a great output of theoretical literature which seeks to explain or elucidate the facts of the subject.

The volume under review is a collection of reprints of 19 papers (all in English) which have appeared in the decade between 1950 and 1960. It begins with three papers by Fröhlich and finishes with an English translation of a monograph by Bogoliubov, Tolmachov and Sirkov. The papers are all theoretical. But the reader who seeks to get behind the mathematical formalism and understand the physics of the subject will find the review article by C. G. Kuper which appears as the 17th paper in the volume fairly useful.

C. V. R.

**The Chemistry and Function of Proteins,** Second Edition. By Felix Haurowitz. (Academic Press, Inc., New York-3), 1963. Pp. xiv + 455.

So many books now-a-days are the joint productions of numerous specialists contributing individual articles to a volume of substantial size appearing under the editorship of the person whose name is on the title page, that it is rather refreshing to find a book which is not of that kind but is the product of an individual author responsible for the contents of the entire volume. Difficult as it may seem at the present time in view of the enormous multiplication of the number of periodicals whose contents have to be surveyed and assessed by any

one who wishes to keep abreast of progress in his speciality, nevertheless, the presentation of an entire field of knowledge by one author in one single book has much to commend it. There is a great gain in the coherence and the intelligibility of the presentation, assuming of course that the author can see both the wood and the trees in the forest of present-day knowledge and frame the picture of it which emerges from his own mind.

A book under the slightly different title of *The Chemistry and Biology of Proteins* by Professor Haurowitz was published by the Academic Press in the year 1950. This book was so well accepted by the scientific world that it soon had to be reprinted. It was also translated into Russian and Japanese. These successes encouraged the author to write this second edition which was clearly needed in view of the great progress made of recent years in obtaining an insight into the problems presented by the structure of proteins. Indeed, nearly half the present volume is devoted to the methods used in work on structure problems. The greater part of the rest of the book is concerned with the properties of those proteins which have been investigated most thoroughly. The final chapter of the book deals with the subject of Protein Biosynthesis which at the present time is receiving a great deal of attention and is therefore in a state of flux.

Proteins are very much a matter of profound interest from the standpoint of human values. They form a substantial part of the food we consume, and the transformations they undergo in the digestive tracts before they are finally absorbed and incorporated into living flesh and blood concern us very much. The blood which courses through the heart and through the arteries and veins and contains that wonderful substance known as Hemoglobin, the metallic element iron in association with the organic compound protoheme and the protein compound known as globin playing a supremely important role in keeping us all alive. Still another vital role is played by the muscles in the human body, in which a mechanico-chemical process enables the energy of our food to be transformed into physical work. These are only two out of the very great number of roles which proteins play in human life and activity. Professor



Haurowitz in his book sets out the present position of knowledge regarding all these matters.

The exposition of the subject in the book is such as to attract the reader's attention and convey to him some idea of the reason why men of science today in diverse fields are so deeply interested in proteins, their structure and behaviour. It is the reviewer's belief that this book would serve admirably the purpose of enlarging the number of those who are interesting themselves in this field and would thus reward the efforts which the author has made to put forward a clear and authoritative exposition of it.

C. V. R.

**Kirk-Othmer:** *Encyclopedia of Chemical Technology* (Second Edition), Vol. I. (Published by Interscience Division, John Wiley & Sons Inc., 440, Park Avenue South, New York-16, N.Y.), 1963. Pp. xix + 990. Price \$45.00 each. Subs. \$35.00.

The projected plan of the Publishers to bring out a second edition of this monumental work *Encyclopedia of Chemical Technology* will be acclaimed by chemical technologists all over the world. Users of this *Encyclopedia* will recollect that the publication of the first edition comprising of 15 volumes was spread over the years 1947 to 1956. Then two Supplementary volumes were issued, the first in 1956 and the second in 1960, which attempted to bring the contents of the original volumes more up-to-date.

The need for this new undertaking goes without saying. It should be realised that the first volume, containing titles Abrasives to Aluminium, was published sixteen years ago. According to the phased time schedule, the eighteen volumes of the new second edition will take an almost equal number of years for their publication as those of the first edition. Thus corresponding volumes of the first and the second editions will be separated by an interval of about 16 years. Considering the enormous developments that have taken place in various fields of chemical technology during this interval of time it is to be expected that the new edition will not merely be a revision of the first edition but a new *Encyclopedia* altogether, with every article re-written and a number of new articles brought in. This the Publishers have promised, and this is evident also from a perusal of the first volume under review.

Some of the new articles added are: Abherents, Ablation, Acetal Resins, Acrylamide, Actinides, Aerosols, Algal cultures, Alkanol-

amines, Alkylphenols, etc. Articles on major important chemicals are complete in themselves containing a large amount of information from the chemical and technological points of view. Thus the article on Acrylamide,  $\text{CH}_2 = \text{CHCONH}_2$ , a compound which is assuming increasing importance as a chemical intermediate and as a monomer, and whose commercial production began only in 1954, gives first the physical properties, then the chemical properties with appropriate formulæ of reactions of the amide group, and reactions of the double bond; its polymerisation, its chief method of manufacture starting from acrylonitrile, with a flow sheet; its other methods of production, economic aspects of production; specificities and analysis, toxicity and uses, finally followed by a full bibliography of papers.

The article on Alcoholic beverages includes whiskies, gin, brandy, rum and vodka, but the reader who is after Ale will have to wait for Beer in a subsequent volume.

A perusal of the contents will show that not only the chemicals are included but also such processes of theoretical interest as absorption, adhesion, adsorption alkylation, etc. The reviewer was curious to know what Abherents were, and what Ablation had to do with chemical technology. Abherents, or release agents, are defined as solid or liquid films that reduce or prevent adhesion between two surfaces. Obviously it is a newly coined antonym of Adherents. Ablation is used in science by astronomers to describe the process of disintegration of meteors when they enter the earth's atmosphere. Now that we have long-range missiles, recoverable earth-satellites, interplanetary vehicles, etc., which after travelling outside the earth's atmosphere must re-enter it, they may be called man-made meteorites, and to ensure their survival their surface materials or coatings must be such that they erode or ablate slowly to avoid damage to the payload. Such materials are called Ablatives! And so they hold a high place in modern chemical technology, and a high place in this *Encyclopedia* also, though coming second only to Abherents.

Another welcome feature in the Second Edition of the *Encyclopedia* is that whereas the first edition concentrated on presenting United States technology, and the contributors were all American, in this edition the 1,000 contributors will include many specialists from abroad, the intention being to present chemical technology, wherever it is found, without regard to international boundaries.

The volume is beautifully printed, beautifully got up (7¼ by 10¼), with numerous diagrams, graphs and flow sheets, and useful bibliography of up-to-date literature at the end of each article. Although the single volume is priced \$45 each, the subscription price affords a substantial concession and is only \$35. The *Encyclopedia of Chemical Technology* which is a must for all scientific and technological libraries will adorn any sophisticated bookshelf.

A. S. G.

**Progress in Astronautics and Aeronautics.**  
(Academic Press, New York and London), 1963.

**Volume 9.—Electric Propulsion Development.**  
Edited by Ernst Stuhlinger. Pp. lx + 748. Price \$10.50.

**Volume 10.—Technology of Lunar Exploration.**  
Edited by C. I. Cummings and H. R. Lawrence. Pp. xv + 989. Price \$13.75.

The attempt to land a man on the moon is perhaps the most daring and costly single project ever conceived in the history of science. The scientific and technological problems involved in the manned exploration of the moon are quite varied and range from astromedicine at one end to space propulsion at the other end. The thirty-six papers collected in Volume 10 of the progress in Astronautics and Aeronautics will provide the reader with ample material of the diverse scientific and engineering problems encountered in the lunar flight programme.

The volume *Technology of Lunar Exploration* is divided into six sections and runs into approximately thousand pages. The first paper by Dr. Kopal describes the theories on the lunar environment and the internal structure of the moon. The other papers in this section describe some activities that are currently under way to achieve a reasonable theory concerning what might be encountered in some of the initial lunar flight programmes. The second section explores the problems associated with the limitations imposed on lunar missions by launch vehicles and launching facilities, and covers launch, midcourse and rendezvous techniques. The third section deals with the spacecraft systems and techniques required for lunar missions. The fourth section deals with the actual landing on the moon and the subsequent surface operations. The various papers in this section deal with the concept of rendezvous on the lunar surface and the actual operations on the surface of the moon. Section five covers

the lunar launch, flight re-entry and the final landing on the surface of the earth. The magnitude and difficulty of the problem of lunar launching will be apparent if we compare it with the size of the operations and the number of people involved in launching a simple weather rocket from the earth. The last section of the book deals with the progress and prospects of some of the U.S. space projects.

Volume 9 of the series on *Progress in Astronautics and Aeronautics* is a collection of technical papers presented at the American Rocket Society Electric Propulsion Conference held at Berkeley in 1962, and deals primarily with the problems of electric propulsion that one encounters in space technology. It is divided into the following four sections: Electrothermal or Arc Jet Propulsion; Electrostatic or Ion Propulsion; Electromagnetic or Plasma Propulsion; and Space Testing and Space Missions. The first section is a collection of papers on the thermodynamics of arcs, on problems of heat and momentum transfer, on chemical processes within arcs and on arc jet design problems. The second section deals with ion sources, the basic ionization processes, the corrosive properties of cesium and ion-optical designs. In the third section, plasma systems are discussed. The fourth section includes papers on flight testing of electric propulsion models, on vertical rocket probes and on satellites, on systems design and systems optimization, and on interplanetary missions.

The two volumes represent the very recent advances made in the propulsion of space vehicles and lunar exploration, and will be warmly welcomed by all space technologists and scientists.

K. S. VISWANATHAN.

**Propagation of Radio Waves.** By B. Chatterjee.  
(Asia Publishing House, Bombay-1), 1963.  
Pp. 114. Price Rs. 10-00.

The author has intended that this book should be useful to post-graduate students in Electrical Communication Engineering and has aimed at a treatment of the subject intermediate between that given in general text-books and that contained in specialised reference books on the subject.

The subject is treated under six chapters starting with the basic considerations of radio wave propagation in the first chapter and proceeding to propagation of, ground wave, space wave, sky wave, in the Ionosphere, and through scatter mechanism, in subsequent chapters. All salient formulæ connected have been mentioned

in the book and the important ones are also duly derived. Each chapter includes at its end a list of useful references relating to the subject dealt with in the chapter. The treatment has in general an emphasis on the Physics involved in radio propagation. This no doubt is unavoidable as the subject is concerned primarily with the radio propagation in the medium in between the transmitting and receiving equipments. Since the book is intended for Engineering students, some references to engineering aspects resulting from the characteristics of propagation would not have been out of place in this book. For example, polarization changes in propagation causing night effects in direction finding and calling for special designs in the aerials for direction finding could have been briefly referred to.

Nevertheless, the book generally satisfies the claim for concise treatment of the subject in between general text-books and reference books.

S. S. MOORTHY RAO.

**Recent Progress in Microbiology—Symposia held at the VIII International Congress for Microbiology.** Edited by N. E. Gibbons. (University of Toronto Press), 1963. Pp. xiii + 721. Price \$ 21.50.

This is a most stimulating volume. It contains the proceedings of the 13 symposia held at Montreal on the occasion of the VIII Microbiological Congress. Attempts to review here details of the many facets of knowledge furnished in this beautifully brought-out volume could only be frustrating to the reader and the reviewer alike. Suffice it to mention that this multi-authored volume provides a good survey of several important aspects of Microbiology not usually covered in reviews as (1) Membrane Permeation, (2) Properties of Isolated Cellular Particles, (3) Insect Microbiology, (4) Psychrophilic Micro-organisms, (5) Enzymes in Soils, (6) Effect of Chemical and Biological Control Measures on Soil Micro-organisms, (7) Mechanisms of Immunity in Infectious Disease, (8) Interference and Interferon, (9) Demonstration of Viruses in Neoplasia, (10) Pleuropneumonia-like Organisms as Agents of Human and Animal Diseases, (11) The Virulence of Staphylococci, (12) Microbial Classification, and (13) Influence of the Environment on the Epidemiology of Mycoses.

Appropriately, some aspects of Industrial Microbiology covered during the panel discussion on topics like Genetics, Microbial Production of Amino-Acids, and Evolutionary Operation and Horizons are also included. It is valuable to have up-to-date data on diverse aspects of Microbiology readily available in a single volume and to this end the book is indispensable. The type used in printing is large and easy to read and the paper is of good, non-glossy stock; typographical errors are few. The volume will surely find a place in most libraries, but individual purchasers are likely to be deterred by the high price.

J. V. B.

#### Books Received

**Reports on Progress in Physics**, Vol. XXVI. Executive Editor: A. C. Stickland. (The Institute of Physics and Physical Society), 1963. Pp. 472. Price £ 5-0-0.

**Control of Lipid Metabolism.** By J. K. Grant. (Academic Press, Inc., New York), 1963. Pp. xii + 191. Price 37 sh. 6 d.

**Treatise on Analytical Chemistry**, Part I. By I. M. Kolthoff, Phillip, J. Living and Ernest, B. Sandell. (Interscience Publishers, Inc.), 1963. Pp. 1751-2704. Price \$ 25.00.

**Modern Developments in Audiology.** By J. Jerger. (Academic Press, Inc.), 1963. Pp. xii + 446. Price \$ 12.00.

**Celestial Objects for Common Telescopes**, Vol. II. *The Stars.* By Rev. T. W. Webb. (Dover Publications), 1963. Pp. xxvi + 255. Price \$ 2.25.

**Error and Eccentricity in Human Belief.** By Joseph Jastrow. (Dover Publications), 1963. Pp. xv + 394. Price \$ 1.85.

**Mathematical Theories of Planetary Motions.** By Otto Dziobek. (Dover Publications), 1963. Pp. vi + 294. Price \$ 2.00.

**International Review of Connective Tissue Research**, Vol. I. By David A. Hall. (Academic Press, Inc), 1963. Pp. xii + 401. Price \$ 14.00.

**Lake Baikal and Its Life.** By M. Kozhov. (Dr. W. Junk, Publishers, The Hague), 1963. Pp. vi + 344. Price \$ 10.00.

**The Carnegie Institution of Washington Year-Book for 1962-63.**

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 SCIENCE NOTES AND NEWS
 

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## Award of Research Degree

Andhra University has awarded the Ph.D. Degree in Botany to B. S. M. Dutt for his thesis entitled "Embryological Studies in *Amaryllidaceæ*".

Occurrence of *Meredolus* Sp. on Coconut

T. Kailasa Rao and T. Srirama Rao, Coconut Research Station, Ambajipeta P.O., East Godavari District, write :

At Ambajipeta (Andhra Pradesh), occurrence of *Meredolus* sp. (Curculionidæ) was recorded on mature male flowers of *Cocos nucifera* (*typica*). They feed on filaments and anthers and occur right through the year. This appears to be the first record of its incidence on coconut in India. Thanks are due to the Director, Zoological Survey of India, Calcutta, for identification of the weevils.

## Alkathene House for Orchid Culture

S. K. Kataki of the Botanical Survey of India, Eastern Circle, Shillong, writes :

Establishment of the National Orchidarium in Shillong (1,500 m.) by the Government of India provides a number of devices to grow wild orchids artificially. In natural condition generally orchids require 60-80% relative humidity with a minimum temperature of 21° C. (70° F.) daytime and 12-7° C. (55° F.) at night. Last few years experience has shown that, while growing artificially, most orchid specimens died during winter due to heavy frost fall and low temperature. This has led to adapt an idea of experimenting on the culture of orchids in a transparent alkathene house and accordingly a circular alkathene house (32 ft. in diam.) was built. 1,500 specimens of orchids (including a few foreign orchids) are now under cultivation. Temperature and relative humidity were recorded both inside and outside the alkathene house.

It is observed that the temperature and humidity inside the alkathene house are relatively more than those outside and at the same time orchids are completely protected from frost during winter nights while allowing light to enter inside the house through the alkathene. Now, it has been inferred that in a cold place like Shillong use of transparent alkathene house will provide a device for growing orchids artificially.

## Forecasting Earthquakes from Seismo-Magnetic Disturbances

The existence of a correlation between magnetic disturbances and seismic activity has been suspected for a long time, but the effect could not be satisfactorily demonstrated for want of adequate facilities for measuring unambiguously such changes in the magnetic field. However, sufficient evidence had been accumulating in Japanese literature to justify a renewed examination of the problem. Japanese scientists compared magnetic surveys before and after earthquakes and plotted differences which they associated with seismic activity. They presumed that the magnetic effects were due to thermal changes accompanying the earthquakes since a local rise in the Curie point isotherm (depth at which the temperature is equal to the Curie point of the dominant magnetic mineral) demagnetizes a certain volume of rock and causes a change of field at the surface. This explanation is, however, untenable because the required movement of the isotherm is much more rapid than thermal diffusion will allow.

A more plausible explanation will be to base the seismo-magnetic effects observed at the surface to the, now, well-recognized piezomagnetic properties of rocks. Rock magnetization changes reversibly with the stress applied, and lately study of palæomagnetism has given an impetus to renewed investigations of piezomagnetic effects in rocks. The subject has been recently reviewed by F. D. Stacey of the Meteorological Office Research Unit, Cambridge, wherein quantitative relations have been established for the variation of magnetization with compression in different directions in magnetic rocks. These relations can be used to calculate the magnetic disturbances expected to be produced at the surface by rocks which undergo seismic pressure.

An earthquake must be preceded by a build-up of stress, normally over a period of months, and the magnetic effect must therefore give a pre-indication. The possibility of forecasting earthquakes on this basis deserves consideration because reliable instruments of required accuracy (e.g., proton precession magnetometer) are available, and a weekly survey of the total magnetic field with such instruments may well be sufficient to indicate the location of an

Impending earthquake.—(*Nature*, 1963, 200, 1083.)

#### Earth's Convection Currents and Gravitational Irregularities

Measurements of the paths followed by artificial satellites have revealed irregularities in the earth's gravitational field. The irregularities have been generally interpreted as due to the departure of the earth from being a true sphere, and in fact these gravitational variations have been used to compute more accurately the figure of the earth.

S. K. Runcorn, of the University of Newcastle upon Tyne, in a note to *Nature* suggests that the gravitational irregularities may as well be a result of convection currents in the earth's mantle—the hot layer of rock immediately below the crust. According to him rising and descending convection currents in the mantle could produce changes in the density of various parts of the mantle sufficient to account for the observed irregularities in the earth's gravitational field. It is to be noted that when the irregularities as obtained from satellite data are plotted on a world map, a remarkable coincidence is observed. All five areas of low gravity detected by satellite coincide quite closely with regions of the Mid-Ocean Ridge: the globe-girdling chain of mountains that is being characterized by rising convection currents. Such currents mark zones of expansion in the mantle and could be expected to produce regions of low gravity.

Satellite observations have also revealed four areas of abnormally high gravity. Two of these coincide with zones of compression and probable descending currents in southern Europe and the Andes. The other two regions of high gravity—below South Africa and in the Pacific north and east of Australia—are not so easily matched to the earth's topographic features. But Runcorn, an advocate of the theory of continental drift, suggests that continental movements may produce a clue to these and other related puzzles.—(*Scientific American*, January 1964.)

#### Disintegration of Lithium-7 into Triton and Alpha-Particle

According to G. R. Bishop and M. Bernheim of the Linear Accelerator Laboratory, Orsay, experiments on inelastic scattering of electrons of 150 MeV. by a target of  $\text{Li}^7$  have revealed a scattering cross section at 5.7 MeV which could

not be explained in terms of the known levels of  $\text{Li}^7$ . The experimenters associate this inelastic scattering with the disintegration of  $\text{Li}^7$  into triton and an alpha-particle which occurs with a threshold energy of 2.465 MeV.—(*Physics Letters*, January 1, 1964.)

#### Nuclear Nomenclature: Helion for Alpha-Particle

Professor Pauling has suggested that the word helion be used for the  $\alpha$ -particle, the nucleus of helium atom.

The names electron, neutron, proton, deuteron, and triton are convenient, and are generally used. Helion for the helium-4 nucleus would be a convenient word to use in expressions such as bombardment with helions, helion-helion collisions, helion emitters, and the helion model of the nucleus.—(*Nature*, 1964, 201, 60.)

#### Production of Acetylene from Coal, Using a Plasma Jet

The plasma jet is a convenient tool for the production of high temperatures, 8,000°–15,000° K. Scientists of the British Coal Utilisation Research Association have succeeded in obtaining a high percentage of acetylene from coal using a plasma jet.

The experiments were carried out with a plasma jet of conventional electrode arrangement, the arc striking between a tungsten rod which acted as the cathode and copper tube as the anode. The material, a high-volatile coal ground to 72 B.S. mesh, was fed at rates of 1 g./min. into the plasma jet from a fluidized bed by a subsidiary stream of argon. The gases leaving the jet passed into a steel cooling chamber and were collected in a polythene container, and later analysed by wet, gas-chromatographic, and infra-red methods. Analysis showed that acetylene represented more than 95% of the hydrocarbons present.

From calculations it was estimated that the thermal decomposition of coal in a pure argon plasma results in 20% conversion of the carbon in the coal to carbon in acetylene, and that an addition of 10% of hydrogen to the arc gas increases this conversion to 40%.

The reaction products from the thermal decomposition of the coal in the plasma jet were almost entirely either solid (soot) or gaseous, there being negligible amounts of tarry material usually obtained at low temperature treatment.—(*Nature* 1963, 200, 1313.)

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# STIMULATED RAMAN SCATTERING AND RELATED PARAMETRIC EFFECTS

ROBERT W. HELLWARTH

Hughes Research Laboratories, Malibu, California

## ABSTRACT

Stimulated Raman scattering (SRS) of light from frequency  $\omega_p$  to the Stokes shifted frequency  $\omega_p - w$  has been extensively studied experimentally and theoretically. Under certain experimental conditions this SRS is accompanied by weaker emission at frequencies  $\omega_p \pm nw$  where  $n$  may take on many positive integral values. It is the purpose of this paper to make a first step toward a fundamental understanding of this multiplet of lines (which we call an "SRS ladder") by calculating a somewhat unrealistic model problem where the Raman-active material is enclosed in a perfectly conducting cavity and illuminated by an absolutely monochromatic source. These are the least unrealistic boundary conditions we have found which leave the coupled Maxwell and non-linear matter equations amenable to approximate solution. We use Placzek's classical model of Raman-active vibrations to derive the matter equations. When conditions favor SRS ladder production, we find that there is significant gain at both  $\omega_p - w$  and  $\omega_p + w$ . However, this hybrid combination of parametric amplification and SRS does not satisfy any of the well-known relations of either nor allow interpretation in terms of a simple photon picture. We estimate the power in the SRS ladder lines by assuming that the output originates from amplified quantum noise and find powers not unlike those from experiments. Ways to extend the model and improve the approximations are discussed.

## I. INTRODUCTION

WHEN a Raman-active material is subjected to intense radiation of angular frequency  $\omega_p$ , then a gain is induced in the material around the frequency  $\omega_s = \omega_p - w$ , where  $w$  is the frequency of a Raman-active vibration. If this gain is sufficient to overcome the losses present, then coherent light, which has the characteristics of laser light, builds up at  $\omega_s$ . This effect has been called stimulated Raman scattering (SRS) because it bears the same relation to ordinary Raman scattering that stimulated emission of radiation bears to spontaneous emission of radiation. SRS has been observed in dozens of materials by a host of experimenters.<sup>1-11</sup> Its basic characteristics have been derived on the basis of ordinary Raman scattering cross-sections in a manner analogous to the way ordinary laser action is predicted from absorption cross-sections or fluorescence data.<sup>12</sup> The derived characteristics agree well with the, albeit limited, experimental results available to date on the fundamental Stokes output at  $\omega_s$ .<sup>13-14</sup>

It was observed, even in the first studies of SRS, that the more active Raman materials produced coherent radiation at double and even triple the fundamental shifts, that is at  $\omega_p - 2w$  and  $\omega_p - 3w$ .<sup>2</sup> Each shifted output was typically less intense by an order of magnitude (or more) than the one preceding it. It was immediately recognized that these "harmonic" lines could not be interpreted as scattering to higher vibrational levels because such transitions are known to be too weak and because small anharmonicities in the shifts were absent.<sup>2</sup> It was conjectured that these harmonics represented repeated

SRS, the photons at each new frequency being scattered in turn by the same mechanism which scattered the original incident photons.<sup>2</sup> As we will see below on theoretical grounds this conjecture is at best only partly true. Also, it has been observed subsequently that under rather more special experimental conditions the first anti-Stokes line at  $\omega_p + w$  and higher harmonics of this at  $\omega_p + nw$  are also produced.<sup>4-11</sup> Although the intensity of the anti-Stokes lines is far greater than in normal Raman scattering, each line was observed to be typically an order of magnitude weaker than its corresponding Stokes harmonic. The special experimental conditions that are required to produce the strong anti-Stokes radiation have not been well defined, but do involve making propagation favorable in certain special modes which, as we discuss in later sections, have their wave vectors (or other mode indices) and frequencies satisfy certain constraints (called index-matching conditions). By contrast, normal (or pure) SRS may occur in practically any low loss wave or mode just as does normal laser action. We will refer to this fundamental SRS Stokes emission together with the weaker emissions at the "harmonics"  $\omega_p + nw$  ( $n = \dots -3, -2, 0, 1, 2, \dots$ ) as an "SRS ladder". It is to the analysis of this SRS ladder that this paper will be devoted.

Several more or less qualitative discussions of the SRS ladder have been published already.<sup>10-11,15</sup> These have been based on examining how two, three, or four given monochromatic plane waves of specified phases tend to give energy to each other *via* the non-linear medium and start to grow or decline from their

assumed values. These approaches show the pure SRS gain, independent of phase, at the fundamental Stokes shift, and they also show that some output is likely to occur at the other SRS ladder frequencies. What is needed, of course, is a solution for the fields that actually will be set up (there are not necessarily a small number of monochromatic waves) by virtue of pumping and the coupling to the Raman-active material. We have attempted to find such a solution for the fields by using the previous energy exchange approaches and various detailed balancing procedures, but we have so far failed to obtain a consistent result with this approach. However, by starting from Maxwell's equations and the equations of motion for the matter, and by choosing particular boundary conditions, we are able to obtain estimates for the SRS ladder power spectrum which (by virtue of their resemblance to results of experiments which use somewhat different boundary conditions) indicate that we have made a fruitful step toward a fundamental understanding of the experimental effects.

In Section II we develop the equations describing the matter from Placzek's classical description of Raman-active vibrations<sup>16</sup> and a phenomenological linear dielectric function (which includes loss and dispersion). Also in this section we complete the specification of the model problem which we will attempt to solve by choosing the boundary conditions on the coupled Maxwell and non-linear dielectric equations to be those for uniform matter enclosed by a perfectly conducting cavity. The sources which drive or initiate the fields will be taken to be externally supplied pump radiation, quantum noise, and other externally applied weak signals.

In Section III we proceed with the aid of further assumptions to solve the model problem by an iterative method of successive approximations. Our results show that, as expected, driving forces are amplified near the fundamental Stokes line (and also to a lesser extent at other Stokes lines by iteration of the pure SRS effect). Moreover, if certain "index-matching" conditions are fulfilled by the dispersion in the material, we find that signals near the fundamental anti-Stokes frequency are also amplified and by an amount (depending on dispersion, cavity characteristics, etc.) which is comparable to the Stokes gain. We find no significant gain at other anti-Stokes lines in the SRS ladder, but energy is supplied to them by a non-linear mixing of the other frequencies. This non-linear mixing may also dominate the

iterated SRS in producing Stokes lines past the fundamental. In order to make quantitative estimates of output, we also calculate in Section III the steady state output power spectrum in the fundamental Stokes and anti-Stokes lines in the same manner as one calculates output spectrum of a normal laser oscillator. We assume that quantum noise supplies the driving forces on which the amplifying mechanism operates. The various parameters are related to ordinary Raman scattering cross-sections, which have been measured for some Raman laser materials, thus yielding absolute numerical estimates of output. It is shown how the intensities of the rest of the SRS ladder are estimated for our model, provided pumping is not too strong. The numerical results for a rectangular cavity show a significant SRS ladder and resemble results of experimental measurements. We conclude that the basic non-linear mechanism we have assumed must play an important role in actual experiments, and that there is very likely real amplification at the first anti-Stokes line for a variety of boundary conditions, a possibility that has not been appreciated.

In Section IV we discuss some of the difficulties in our calculation that result both from the inapplicability of our cavity model to many experiments and from the approximations made in solving the model problem. Ways of improving the model and its calculation are proposed. We have been unable so far to represent our results in terms of multi-photon processes, multi-step processes or any other simple picture resembling those that have been proposed.<sup>10,11</sup> The SRS ladder seems to result from a complete, simultaneous, spatially coincident melding of pure SRS,<sup>12</sup> parametric amplification, and non-linear mixing.<sup>15</sup> The difference between our results and previous discussions of the SRS ladder will also be discussed in Section IV. The extensions of the theory to treat several simultaneous SRS ladders and the combination lines that would arise among them is suggested.

## II. FORMULATION OF MODEL

We will approach the study of the SRS ladder by first assuming that the electromagnetic fields  $E(x, t)$  are large enough that the classical Maxwell equations apply. Just as for lasers, this is true except when it comes to treating the noise sources which drive or initiate these fields; in the optical region these noise sources are almost entirely quantum in origin. However, by using ideas familiar to the theory of masers,



Raman masers, and parametric amplifiers, we may avoid a full quantum treatment by constructing classical noise sources (by Nyquist-like relations for negative losses) which imitate the quantum results. The matter with which the fields interact is assumed to have an electric polarization  $P(x, t)$  which is made up of two parts. One is a normal polarization  $P_1(x, t)$  which is linearly related to the field  $E(x, t)$  by a spatially local relation

$$P_1(x, t) = \int_{-\infty}^{\infty} a(t-s) E(x, s) ds. \quad (1)$$

The second part is  $P_3(x, t)$  which is assumed cubic in  $E(x, t)$  and which is responsible for coupling electromagnetic modes to produce SRS and its related harmonics. If the matter does not possess inversion symmetry there also exists a part  $P_2(x, t)$  of the polarization which is quadratic in  $E(x, t)$  and which produces frequency doubling and mixing and other processes that will not occur near those frequencies which are near the central, strong part of the SRS ladder grouped about the pump frequency  $\omega_p$ . We will disregard  $P_2(x, t)$  in our analysis here. We will assume that  $P_3(x, t)$  is related to the electric fields as if a Raman vibration were the mechanism for the existence of  $P_3(x, t)$ . Garmire and co-workers have suggested that Placzek's classical description of a Raman vibration would describe at least the gross features of SRS and related effects fairly well, and for simplicity we will follow that suggestion here. (A full quantum treatment does point up some different relations and also some alteration of the effect which we will discuss in a later paper.) The Raman vibration gives a resonant non-linearity which generally is the dominant contribution to  $P_3(x, t)$  at frequencies near  $\omega_p \pm n\omega$  where  $n$  is a positive integer (that is, the SRS ladder frequencies). We will ignore in our model other, non-resonant, contributions to  $P_3(x, t)$  which, according to a quantum treatment, exist (with possibly comparable influence to the resonant part).

The pertinent co-ordinates of the matter will be the normal vibrational co-ordinates  $r_\mu(t)$  where  $\mu = 1, 2, \dots, N$  and  $N$  is the number of molecules in the matter. (We will consider only one species or branch of the vibration spectrum to be influential, although this is not always true in practice.) Each vibration is damped at a rate  $b_\mu$  occurs at a frequency  $\omega_\mu$  which is near  $\omega$ , and will be assumed to obey

$$\left( \frac{\partial^2}{\partial t^2} + b_\mu \frac{\partial}{\partial t} + \omega_\mu^2 \right) r_\mu(t) = h_\mu(t) \quad (2)$$

where  $h_\mu(t)$  is the driving force which equals

$-\partial V / \partial r_\mu$  if  $V$  is the interaction energy of the material vibration with the electromagnetic fields. According to Placzek's classical picture, a Raman vibration simply modulates the polarizability so that

$$P_3(x, t) = \sum_\mu r_\mu(t) \alpha_\mu(x) \cdot E(x, t) \quad (3)$$

whence

$$V = -\frac{1}{2} \sum_\mu r_\mu(t) \int d^3x E(x, t) \cdot \alpha_\mu(x) \cdot E(x, t). \quad (4)$$

$\alpha_\mu(x)$  is a polarizability tensor function associated with the  $\mu$ -th vibration. For independent molecules  $\alpha_\mu(x) = \alpha_\mu \delta(x - x_\mu)$  where  $x_\mu$  is the position of the  $\mu$ -th molecule and  $\alpha_\mu$  is a constant tensor;  $\omega_\mu$  is a constant  $\omega$  for a homogeneously broadened line (or spread about  $\omega$  otherwise); and  $b_\mu$  can be taken to be a constant  $b$ . For a Raman-active phonon branch (or collective vibration)  $\alpha_\mu(x) = \alpha_\mu \exp ik_\mu \cdot x$  where  $k_\mu$  is the wave vector of the  $\mu$ -th phonon,  $\alpha_\mu$  a space tensor;  $\omega_\mu(k_\mu)$  is the dispersion function for the phonon branch;  $b_\mu$  is now a function of  $\mu$  which is difficult to assess. In any case we have that

$$h_\mu(t) = \frac{1}{2} \int d^3x E(x, t) \cdot \alpha_\mu(x) \cdot E(x, t). \quad (5)$$

We are only interested in that part of  $r_\mu(t)$  which does not depend on its initial conditions at  $t = -\infty$  but contains only a response to the fields  $E$ . From (2) this response is given by

$$r_\mu(t) = \frac{1}{2} \int_{-\infty}^{\infty} ds g_\mu(t-s) \int d^3x E(x, s) \cdot \alpha_\mu(x) \cdot E(x, s) \quad (6)$$

where

$$g_\mu(t) = \int_{-\infty}^{\infty} d\omega G_\mu(\omega) \exp -i\omega t \quad (7)$$

and its Fourier transform is, from (2),

$$G_\mu(\omega) = (\omega_\mu^2 - \omega^2 - ib_\mu\omega)^{-1}. \quad (8)$$

Substituting (6) in (3) gives for the explicit dependence of  $P_3$  on  $E$

$$P_3(x, t) = \frac{1}{2} \sum_\mu \alpha_\mu(x) \cdot E(x, t) \int_{-\infty}^{\infty} ds g_\mu(t-s) \times \int d^3x' E(x', s) \cdot \alpha_\mu(x') \cdot E(x', s). \quad (9)$$

According to Maxwell's equations we have for our non-magnetic material

$$c^2 \nabla^2 E(x, t) - \frac{\partial^2}{\partial t^2} [E(x, t) + 4\pi P(x, t)] = F(x, t) \quad (10)$$

where  $c$  is the velocity of light in vacuum and  $F(x, t)$  is a driving force made up of the strong external pump source and of the weak quantum noise sources which will be amplified by the transfer of energy from the pump field via the non-linear medium. ( $F$  may also include externally applied forces if one desires to study an amplified configuration.)

The coupled equations (1), (9), and (10) together with boundary conditions on  $E(x, t)$  completely determine the dynamics of the model which we will attempt to solve and which gives rise to SRS and its related harmonic ladder. In experiments where a strong SRS ladder has been observed, regeneration of light by reflections at the boundaries generally has played a crucial role, despite its often small value (typically of order 5% from dielectric reflection). We feel that the closest boundary condition to that which exists in practice and which is mathematically tractable is that of a closed perfectly reflecting cavity; we will study only this cavity model here. To specify the boundary conditions in time, we will ignore transients and look for solutions  $E(x, t)$  which represent causal response to the driving force  $F(x, t)$ . With these conditions in mind, we may proceed, with the aid of some further assumptions and approximations, to solve our model problem.

### III. APPROXIMATE SOLUTION OF MODEL EQUATIONS

We will try solutions of the normal mode form

$$E(x, t) = \sum_n e_n(x) q_n(t) \quad (11)$$

in equations (1), (9), and (10) where

$$\int d^3x e_m(x) \cdot e_n(x) = \delta_{mn} \text{ and}$$

$$(\nabla^2 + k_n^2) e_n(x) = 0. \quad (12)$$

The  $(ck_n)$  are the unloaded resonant frequencies of the cavity. Substituting (11) and (12) in (10) and integrating the result by  $e_n(x) d^3x$  gives

$$\begin{aligned} & \left( -c^2 k_n^2 - \frac{\partial^2}{\partial t^2} \right) q_n(t) - \frac{4\pi\partial^2}{\partial t^2} \\ & \times \int_{-\infty}^{\infty} ds a(t-s) q_n(s) \\ & = 2\pi \sum_{\mu, j, k, l} I_{njkl}^{\mu} \int_{-\infty}^{\infty} ds q_j(t) q_k(s) \\ & \times q_l(s) g_{\mu}(t-s) + f_n(t) \end{aligned} \quad (13a)$$

where

$$\begin{aligned} I_{njkl}^{\mu} &= \int \int d^3x d^3x' e_n(x) \cdot a_{\mu}(x) \cdot e_j(x) \\ & \times e_k(x') \cdot a_{\mu}(x') \cdot e_l(x'), \end{aligned} \quad (13b)$$

and the spatial integration here, and henceforth, is to be taken over the volume of the cavity.

$$f_n(t) = \int F(x, t) \cdot e_n(x) d^3x.$$

With this we have eliminated the space variables and have an infinite set of coupled equations for the mode co-ordinates  $q_n(t)$ . It is convenient to Fourier transform (13) into equations for  $Q_n(\omega) = \int_{-\infty}^{\infty} dt q_n(t) \exp i\omega t$  in terms of the

transforms  $A(\omega)$ ,  $F_n(\omega)$ , and  $G_{\mu}(\omega)$  of  $a(t)$ ,  $f_n(t)$ ; and  $g_{\mu}(t)$ ; then (13) becomes

$$\begin{aligned} & (\omega_n^2 - \omega^2 - i\Delta_n\omega) Q_n(\omega) + F_n(\omega) \\ & = \frac{\omega^2}{2\pi} \sum_{\mu, j, k, l} I_{njkl}^{\mu} \iint d\omega' d\omega'' Q_j(\omega') \\ & \times Q_k(\omega'') Q_l(\omega - \omega' - \omega'') G_{\mu}(\omega - \omega') \end{aligned} \quad (14)$$

where  $\omega_{\Delta_n} = -4\pi \text{Im} A(\omega_n)$  and  $\omega_n^2 = c^2 k_n^2 + 4\pi \text{Re} A(\omega_n)$  determine the "loaded" mode frequencies  $\omega_n$  and damping rates  $\Delta_n$ .

A large pump field exists in the cavity and, for simplicity, we assume it to exist in a single mode which we will label with a "p". To be correct we should assume this field  $q_p(t)$  arises from a large force  $f_p(t)$  and calculate  $q_p(t)$  self-consistently along with all the other mode fields  $q_n(t)$ . However, we will assume that the coupling of the p-mode to other modes drains off negligible pump energy so that  $q_p(t)$  can be assumed to be of a known form. (In practice it is unusual to convert more than 10% of the pump energy to the Raman lines and often very much less.) Furthermore, we will assume that  $q_p(t) = \lambda \cos \omega_p t$  (a monochromatic pump) whence

$$Q_p(\omega) = \lambda \pi [\delta(\omega - \omega_p) + \delta(\omega + \omega_p)]. \quad (15)$$

Because we have assumed that  $Q_p \gg Q_n$  it is evident that the terms on the RHS of (14) containing the highest power of  $Q_p$  are the most important. If we put  $j, k, l = p$  in (14) to obtain what might be the largest term, we actually obtain an uninteresting term that is small because the Raman response  $G_{\mu}(\omega)$  is peaked about a frequency assumed to be far from  $\omega_p$  or any of its multiples. The next largest terms to consider in the RHS of (14) have  $Q_p$  entering twice. Because of the resonant nature of  $G_{\mu}$  the important terms are  $j = k = p$  or  $j = l = p$  and these give equal contributions. As a first approximation, then, we will use only these terms in (14) so that we have first to try to solve

$$\begin{aligned} & (\omega_n^2 - \omega^2 - i\Delta_n\omega) Q_n(\omega) + F_n(\omega) \\ & \approx \omega^2 \lambda^2 \pi \sum_{\mu, l} I_{nppl}^{\mu} \{ G_{\mu}(\omega - \omega_p) [Q_l(\omega - 2\omega_p) \\ & + Q_l(\omega)] + G_{\mu}(\omega + \omega_p) [Q_l(\omega) \\ & + Q_l(\omega + 2\omega_p)] \}. \end{aligned} \quad (16)$$

In a higher approximation, one would consider terms linear in  $Q_p$  on the RHS of (14) to be perturbations on the solution of (16), but we will concentrate mainly on solving (16) in this paper. Equation (16) gives approximately the properties of the fundamental Stokes and anti-Stokes lines of the SRS ladder. The next approximation brings in the first doubly shifted

Stokes and anti-Stokes lines, and higher approximations to (14) bring in the whole SRS ladder; provided that certain "index-matching" conditions can be met in the material; we discuss these later.

To analyze (16) we study first the properties of the space integral required in (13 b) and (16). We use for simplicity the independent molecule model where the index  $\mu$  refers to the  $\mu$ -th molecule;  $g_\mu(t)$  does not depend on  $\mu$ ;  $\omega_\mu = \omega$  and  $b_\mu = b$ ;  $a_\mu(x)$  equals a unit tensor times a constant  $a$  times  $\delta(x - x_\mu)$  and the molecules are uniformly distributed throughout the cavity. The integrals on  $x$  and  $x'$  can be immediately performed, and the required sum over  $\mu$  of (16) is well approximated by an integral over the volume of the cavity:

$$\sum \mu I_{npl}^{\mu} \rightarrow J_{nl} = a^2 \rho \int d^3x e_n(x) \cdot e_p(x) e_l(x) \cdot e_p(x). \quad (17)$$

In order to obtain an estimate of the magnitude of this integral for different  $n$  and  $l$  we have studied  $J_{nl}$  in the "test" case of a rectangular cavity in which the pump mode is a purely longitudinal mode. We have found that (a)  $J_{nl}$  vanishes unless  $l$  refers to a mode of the same longitudinal index as does  $n$  or to a mode with a longitudinal index which is larger than that of the  $p$ -mode by the same amount that the  $n$  index is smaller; (b) for each case in (a) the integral also exists for three sets of transverse indices in  $l$  but one of these sets gives a result twice as big as the other two. We will assume that these transverse modes in (b), or whatever  $l$  modes have non-vanishing  $J_{nl}$  for  $n \neq l$ , are all suppressed except for one [analogous to the kind mentioned in (a)], so that for each  $n$  we may assume  $J_{nl} = 0$  except when  $l$  either equals  $n$  or this other value, which we will label  $i$  (for "idler"). This suppression is possible in practice but, in fact, has not been sought in experiments to date. The error involved in applying this assumption to the case where  $l$  may take on several other values for each  $n$  is not yet known, but we believe that the essential character of the results is the same in either case.

With this assumption, the equations (16) break up into pairs of equations which may be treated separately. We will study a typical pair of such modes which we will label "s" and "i" (for "signal" and "idler" modes respectively). We choose for definiteness  $\omega_s < \omega_p < \omega_i$ . The calculations are simplified by considering  $Q_s(\omega)$  for  $\omega > 0$  and  $Q_i(\omega)$  for  $\omega < 0$  and using  $Q(-\omega) = Q^*(\omega)$  when necessary. The functions  $Q_s$  and  $Q_i$  have peaks near their mode frequencies  $\pm\omega_s$  and  $\pm\omega_i$ ; and we will omit terms

which do not contribute much near the peaks. With this and the resonant character of  $G(\omega)$  in mind, we obtain from (16) the pair of equations

$$[\omega^2 - \omega_s^2 + i\Delta_s\omega + \gamma_{ss}(\omega)] Q_s(\omega) - \gamma_{si}(\omega) Q_i(\omega - 2\omega_p) = F_s(\omega) \quad (18)$$

and

$$[(\omega - 2\omega_p)^2 - \omega_i^2 + i\Delta_i(\omega - 2\omega_p) + \gamma_{ii}(\omega)] Q_i(\omega - 2\omega_p) - \gamma_{is}(\omega) Q_s(\omega) = F_i(\omega - 2\omega_p) \quad (19)$$

for positive  $\omega$  in the vicinity of the frequencies  $\omega_s$  and  $2\omega_p - \omega_i$ . We have used the abbreviations

$$\gamma_{ss}(\omega) = \omega^2 \lambda^2 \pi G(\omega - \omega_p) J_{ss} \quad (20a)$$

$$\gamma_{ii}(\omega) = (\omega - 2\omega_p)^2 \lambda^2 \pi G(\omega - \omega_p) J_{ii} \quad (20b)$$

$$\frac{\gamma_{si}(\omega)}{\omega^2} = \frac{\gamma_{is}(\omega)}{(\omega - 2\omega_p)^2} = -\pi \lambda^2 G(\omega - \omega_p) J_{si}. \quad (20c)$$

A convenient form for the solutions of (18) and (19) is

$$D(\omega) Q_s(\omega) = F_s(\omega) C_i(\omega - 2\omega_p) + F_i(\omega - 2\omega_p) \gamma_{si}(\omega) \quad (21)$$

$$D(\omega) Q_i(\omega - 2\omega_p) = F_i(\omega - 2\omega_p) C_s(\omega) + F_s(\omega) \gamma_{is}(\omega) \quad (22)$$

where

$$C_s(\omega) = \omega^2 - \omega_s^2 + i\Delta_s\omega + \gamma_{ss}(\omega) \quad (23a)$$

$$C_i(\omega) = \omega^2 - \omega_i^2 + i\Delta_i\omega + \gamma_{ii}(\omega + 2\omega_p) \quad (23b)$$

$$D(\omega) = C_s(\omega) C_i(\omega - 2\omega_p) - \gamma_{is}(\omega) \gamma_{si}(\omega). \quad (23c)$$

We see that the  $\gamma_{si}$  and  $\gamma_{is}$  are a kind of parametric coupling coefficient; when they are large enough, gain is seen to exist in the  $i$  (idler) as well as the  $s$  (signal) mode. When they vanish the modes become independent, the  $s$ -mode still experiencing gain from the  $\gamma_{ss}(\omega)$  term, but the  $i$ -mode experiencing added loss from the  $\gamma_{ii}(\omega)$  term. The latter gain (loss) is the normal SRS expected in an isolated Stokes (anti-Stokes) mode. This uncoupled case has been studied in detail before;<sup>12,13</sup>  $\gamma_{ss}/\omega_s$  is essentially the  $\Gamma_\beta$  of reference (12), which has been evaluated for the 1345 cm<sup>-1</sup> line of nitrobenzene from experimental cross-sections.<sup>13,14</sup> For a cavity uniformly filled with nitrobenzene and pump photons at 6943 Å,  $\gamma_{ss}/\omega_s$  is  $[3 \times 10^{-8}$  times the density of pump photons in cm<sup>-3</sup>] per sec. The other  $\gamma$ 's may be inferred from (20).

However,  $\gamma_{si}$  and  $\gamma_{is}$  appear to be almost never small but are rather of the order of  $\gamma_{ss}$  and  $\gamma_{ii}$ . That is, for each mode  $s$  there appear generally to be several modes  $i$  for which  $\gamma_{is}$  is of the order of  $\gamma_{ss}$  and that  $i$ -mode for which  $\gamma_{ii}$  is

largest is the one we have assumed to be the mate in the separable pairs of modes. Nevertheless from (21) and (22) we see that  $Q_s$  and  $Q_i$  will still be essentially de-coupled (as if  $\gamma_{is} \approx \gamma_{si} \approx 0$ ) if  $\omega_s + \omega_i + \delta\omega$  do not lie within a mode linewidth  $\Delta$  of  $2\omega_p$ . [Here  $\delta\omega$  represents an effective shift that results from the dispersion that accompanies Raman gain (loss) and the parametric gain (loss), similarly as a maser frequency can be "pulled" by the dispersion accompanying maser gain. We will henceforth redefine  $\omega_s$  and  $\omega_i$  to include this added shift, whence the frequency-matching condition is simply  $\omega_i + \omega_s = 2\omega_p$ .] Most  $s$ -modes will not have their corresponding  $i$ -modes obey this frequency-matching condition and therefore will exhibit SRS in the simple form studied previously.

There will be a small fraction of  $s$ -modes, however, which do have their  $i$ -modes at propitious frequencies, and these latter will exhibit gain and will help to form the basis of an entire SRS ladder. This coincidence of large  $J_{si}$  and matched frequencies is analogous to what has been called "index-matching" or "phase-matching" in a 4-photon process involving plane travelling waves.<sup>11,15</sup> In that context "index-matching" meant the simultaneous conservation of momentum and energy among the photons (and also possibly phonons if they are created and annihilated too). We will also use the term "index-matched" to describe our strongly coupled cavity mode pairs. To make a closer tie between our model theory and experiment, we will examine the average energies in the index-matched mode pairs when  $F_s$  and  $F_i$  are noisy driving forces. This procedure is analogous to the usual calculation of laser oscillator power which is also presumed to arise from amplified noise.

To determine the appropriate values of  $F_s$  and  $F_i$  to use to compute the steady state output of our model, we will assume for simplicity that we are in the quantum limit where the temperature may be assumed much smaller than any of the frequencies involved (expressed in units of  $k/\hbar$ ). We know from the theory of quantum noise in lasers,<sup>17</sup> simple SRS lasers,<sup>18</sup> and ordinary parametric amplifiers<sup>19</sup> that the quantum noise in a given channel is obtained by associating with each negative loss rate  $\delta$  in any channel impedance (defined in the same sense that the  $\Delta_i$  and  $\Delta_s$  are positive loss rates in the idler and signal channels) a noise source in that channel which has a power spectrum, for  $\omega > 0$ , of

$$\langle |F(\omega)|^2 \rangle_{Av} = 2\hbar\omega\delta(\omega) \quad (24)$$

and which is even in  $\omega$ . From an examination of (18) and (19) we would guess that if these theories were extended to the present "mixed" case that the appropriate  $\delta_s$  and  $\delta_i$  to use in (24) for our  $s$ - and  $i$ -channels are

$$\delta_s(\omega) = -\frac{\text{Im}\gamma_{ss}(\omega)}{\omega} \quad (25)$$

and

$$\delta_i(\omega - 2\omega_p) = -\text{Im}\left[\frac{\gamma_{is}(\omega)\gamma_{si}(\omega)}{\omega C_s(\omega)}\right] \quad (26)$$

because these are the only negative loss terms among those that appear as analogies to the  $\Delta_s$  and  $\Delta_i$  parts of the total impedances seen in the  $s$ - and  $i$ -channels respectively.

We can now compute the average energy

$$U_s = \omega_s^2 \int_0^\infty \langle |Q_s(\omega)|^2 \rangle_{Av} \frac{d\omega}{\pi} \quad (27)$$

in the signal mode by using (25) and (24) in (21), provided  $F_i$  is put equal to zero because we have obtained an effective  $F_s$  to represent all noise contributions combined. That is, to evaluate (27) we use (24) and (25) in

$$\begin{aligned} \langle |Q_s(\omega)|^2 \rangle_{Av} \\ = \langle |F_s(\omega)|^2 \rangle_{Av} \left| \frac{C_i(\omega - 2\omega_p)}{D(\omega)} \right|^2, \quad \omega > 0. \end{aligned} \quad (28)$$

Similar remarks apply to the calculation of the idler mode energy  $U_i$ . We will consider only the experimentally interesting case where  $\omega_s$  is within a small fraction of the normal Raman half width  $b$  of  $\omega_p - \omega$ . We suppose the pump amplitude  $\lambda$  is large enough so that gain and output are high in the steady state. The output  $Q_s$  will be highly peaked at (or very near) frequency  $\omega_s$  due to the highly peaked nature of  $1/D(\omega)$ . Therefore, it will be accurate to take outside the integral all factors in the integrand except  $|D(\omega)|^{-2}$  and evaluate them at  $\omega = \omega_s$ . The peak near  $\omega$  in  $|D(\omega)|^{-2}$  arises mainly from a pair of poles at  $\omega = \omega_1$  and  $\omega_1^*$  of  $|D(\omega)|^{-2}$  considered as a function of complex  $\omega$ . Therefore the desired integral is well approximated by a contour integral in the complex  $\omega$ -plane giving (suppose  $\omega_1$  is the pole lying above the real axis)

$$\begin{aligned} U_s \approx \omega_s^2 \delta_s(\omega_s) \hbar\omega_s \\ \times \frac{|C_i(\omega_s - 2\omega_p)/\bar{D}(\omega_s)|^2}{\text{Im}\omega_1} \end{aligned} \quad (29a)$$

where

$$\bar{D}(\omega) \equiv \frac{D(\omega)}{(\omega - \omega_1^*)}. \quad (29b)$$

A good estimate of  $\omega_1$ , and hence of  $\bar{D}$ , can be easily obtained by a study of (23) for any given set of values for  $\lambda$ ,  $J_{si}$ , etc. When the

$s$ - and  $i$ -modes are not index-matched, it is easy to verify that (29) reduces to the famous relation of Schawlow and Townes between the power  $\Delta_s U_s$  and linewidth of laser oscillation in a single mode.<sup>17</sup> Javan has already pointed out that this should happen because the laser formula should also apply to SRS or Raman lasers.<sup>18</sup>

When index-matching applies ( $\omega_i + \omega_s = 2\omega_p$ ) and  $U_s$  is large, then  $U_i$  is also large and is found in exactly the same manner as for  $U$  to be for high gain

$$U_i \approx \frac{U_s \omega_i^3 \operatorname{Re} [\gamma_{is}(\omega_s) \gamma_{is}(\omega_s)]^2}{\{[\Delta_i \omega_i - \operatorname{Im} \gamma_{ii}(\omega_s)]^3 \omega_s^3 \operatorname{Im} \gamma_{ss}(\omega_s)\}} \quad (30)$$

In order to obtain an order of magnitude estimate for  $U_i/U_s$ , we have used the values of the  $\gamma$ 's that obtain for longitudinal modes in a rectangular cavity. In this case  $\operatorname{Im} \gamma_{is}(\omega_s) \approx (\omega_s/\omega_i)^2 \operatorname{Im} \gamma_{ii}(\omega_s) \approx -2|\operatorname{Re} \gamma_{is} \gamma_{ss}|^2 (\omega_s/\omega_i) \approx -1.29 \Delta_s \omega_s$  if we take  $\Delta_i = \Delta_s$ . For the typical case  $\omega_i = 5\omega_s/4$ , (30) then gives  $U_i \approx 0.02 U_s$  in the high gain limit. This crude estimate, which is not in serious discord with experimental fact, gives an anti-Stokes output of only a few per cent of the Stokes but it could be altered greatly either up or down by different values of the  $J_{si}$  integrals.

It is interesting to note that in the course of the above estimation of  $U_i$  for full index-matching, we found that the pump amplitude  $\lambda_0$  required for high gain was only  $(1.29)^{1/2} \approx 1.1$  times that required for high gain with pure SRS which would occur with no index-matching. Looked at from another point of view, this shows that, for a given pump amplitude, the parametric coupling reduces the output at the Stokes frequency from that which would be emitted in the absence of coupling.

The next step in a full solution of the equations (14) would be to include terms in the RHS of (14) that are linear, as well as quadratic, in the pump field  $Q_p$ , and then to study the corrections to the solutions (18) and (19) (which give significant output only in modes near the Stokes, and possibly anti-Stokes, frequencies). The largest corrections are expected to come from the terms on the RHS of (14) which contain the first approximate  $Q_n$  quadratically and the  $Q_p$  linearly. (This is assuming of course that successive corrections are really successively smaller.) These terms give corrections to the first approximate  $s$  and  $i$  amplitudes which are of order  $Q_s/Q_p$  smaller; we will not study these corrections here. More interestingly, these terms also give significant

output in the neighborhood of doubly (up or down) Raman shifted frequencies  $\omega_p \pm 2\omega$ , provided certain index-matching conditions can be met. Let us label modes in the neighborhood of  $\omega_p + 2\omega$  or  $\omega_p - 2\omega$  by the indices  $u$  (for "up") or  $d$  (for "down") respectively. Then, since in (14)  $j=p$  gives only terms which correct the  $s$  and  $i$  modes, the main contribution to  $Q_u$  and  $Q_d$  from (14) is obtained from  $k$  or  $l=p$ , each of which contributes equally.

Let us consider first the  $u$ -mode amplitude  $Q_u$ . An examination of the first and higher order contributions to  $Q_u$  indicates that there is little or no gain introduced into  $u$ -modes so that amplified quantum noise is not important here and we can neglect  $F$ . Therefore, (14) gives as a first approximation for  $Q_u$  ( $\omega$  near  $\omega_u$ )

$$\begin{aligned} (\omega_u^2 - \omega^2 - i\Delta_u \omega) Q_u(\omega) \\ \approx \omega^2 \lambda \sum_{\mu, i, l} I_{uip l}^{\mu} \int d\omega' Q_i(\omega') G_{\mu}(\omega - \omega') \\ \times [Q_l(\omega - \omega' - \omega_p) + Q_l(\omega - \omega' + \omega_p)] \end{aligned} \quad (31)$$

where the most important  $l$ -modes are among the energetic  $s$ - and  $i$ -modes of (18) and (19), both because these  $Q_l$  are the largest and because they are selected by the resonant nature of  $G_{\mu}(\omega)$ . In most cases even when the  $l$  as well as the  $i$  indices refer to "i-modes" they will not be the same "i-modes"; and if  $l$  is an "s-mode" it will not be the coherent mate to the "i-mode". Therefore, the steady state spectral content  $\phi_u(\omega) \equiv \langle |Q_u(\omega)|^2 \rangle_{\text{st}}$  of the  $u$ -mode can be estimated from (31) assuming the  $Q_i$  and  $Q_l$  to be statistically independent amplified Gaussian noise of magnitudes given by (21) and (22):

$$\begin{aligned} \phi_u(\omega) &= \omega^4 \lambda^2 |\omega^2 - \omega_u^2 + i\Delta_u \omega|^{-2} \sum_{i, l} \int d\omega' \\ &\times |\sum_{\mu} I_{uip l}^{\mu} G_{\mu}(\omega - \omega')|^2 \phi_i(\omega') \\ &\times [\phi_l(\omega - \omega' - \omega_p) + \phi_l(\omega - \omega' + \omega_p)]. \end{aligned} \quad (32)$$

From (32) we see that significant energy will be delivered to the  $u$ -mode only when the following conditions are met. First, there is the relatively weak condition that  $\omega_u - \omega_i$  is within a Raman linewidth of the Raman vibration frequency  $\omega_{\mu} = \omega$ . (We will continue to consider the common example in which  $\omega_{\mu}$  and  $G_{\mu}$  are independent of  $\mu$ .) Secondly, there are the two stronger frequency conditions that either  $\omega_u - \omega_i + \omega_p$  or  $\omega_u - \omega_i - \omega_p$  lie within  $\Delta_u$  of  $\omega_l$  (or both do), in which cases  $\omega_l$  will be another  $i$ -mode (call it  $i'$ ) or an  $s$ -mode respectively. For  $u, i, i'$ , and  $s$ -modes satisfying these frequency conditions there are the third requirements that  $\sum_{\mu} I_{uip s}^{\mu}$  and/or  $\sum_{\mu} I_{uip i'}^{\mu}$  are large. If we were dealing with plane waves rather

than with standing waves, these latter conditions would produce the more transparent relations among the selected mode wave vectors:

$$k_u = k_i + k_p - k_s \quad (33)$$

and

$$k_u = k_i + k_i' - k_p \quad (34)$$

which have been derived by Garmire *et al.*<sup>15</sup> on different grounds. It is suggestive that where Terhune reports a single ring of primary anti-Stokes emission from benzene<sup>11</sup> (just as we would expect from the single index-matching condition found there), he also reports a double ring for the doubly shifted anti-Stokes emission, and these latter two rings may well correspond to the two possible index-matching conditions found here.

With regard to the doubly-shifted-Stokes mode amplitudes  $Q_d$ , the same things may be said as for the  $Q_u$ , whence, (32)–(34) apply with  $d \leftrightarrow u$  and  $i \leftrightarrow s$ . However, there is another possible strong source for  $Q_d$  to be found in the next or second correction terms in which  $Q_p$  does not appear as a factor on the RHS of (14). This is the process whereby the  $Q_s$  acts as a pump to produce gain and pure SRS in the  $d$ -modes. This process was the first one proposed to account for the doubly shifted Stokes lines observed<sup>2</sup> and, since this process has no index-matching requirement on the  $d$ -modes, it can dominate when dispersion in the material or mode quenching prevents the fulfilment of either of the two index-matching conditions required for the otherwise stronger processes. Of course, SRS and the index-matched processes could all exist simultaneously to varying degrees. The arguments given here can be extended to write approximate equations for the amplitudes of the other lines in the SRS ladder and the concomitant index-matching conditions where they apply.

#### IV. DISCUSSION

To analyze experiments in which the Raman-active material is not bounded in a way which resembles a perfectly conducting cavity, more appropriate boundary conditions must be considered. A study of plane-travelling waves analogous to our cavity calculation would seem to be a reasonable next step, this case being somewhat closer to experiments where the irradiated matter has very little reflection at its boundaries. A first look at this plane-wave case indicates that the results will be very similar to those for the cavity; the cavity can be nearly thought of as folded plane waves.

Of greater interest will be the replacement of Płaczek's classical model of Raman vibrations

by a quantum treatment. That is, our equation (9) should be replaced by

$$P_3(x, t) = \text{Trace} [\rho(t) P_{op}(x)] \quad (35)$$

expanded to third order in the electric fields. Here  $\rho(t)$  is the density matrix in the Heisenberg representation for the matter and  $P_{op}(x)$  is the polarization density operator. A first look at (35) shows that a term of the form of (9) will again be present together with other terms, the largest of which seems to be interpretable as non-linear (field dependent) dielectric dispersion.

Eventually a full quantum treatment in which the fields are also quantised should be made, but the results of this are expected to be of less physical interest than the new terms introduced by (35). The main result of this field quantization is expected to be a verification or modification of the quantum noise spectra which we have guessed at by "extrapolation" in equations (25) and (26).

Our treatment of the pump field as a given monochromatic field raises several difficulties. First, the field itself  $Q_p$  is not given; only the external driving force  $F_p(\omega)$  can be assumed to be given. For monochromatic  $F_p(\omega)$  our equations (18) and (19) would be augmented by a third equation for  $Q(\omega)$ . The solution of this trio proceeds with little added difficulty and tells how much pump fields are reduced by the SRS ladder output. (Of course  $Q_p$  will never exceed the value at which any mode gain becomes infinite.) However, as the drain on the pump field becomes significant, our method of solution which depended on the progressive smallness of various emitted spectral lines soon fails. Nevertheless, starting from  $F_p$  rather than from a given  $Q_p$ , may still be of some interest. More important in practice is the fact that the pump field is not monochromatic or confined to a single mode. That the pump is turned on and off in the span of typically 40 nsec broadens its spectrum, but the spectrum is generally even broader than this would imply. The lasers which are used as pump sources generally have an output spectrum of the order of  $0.1 \text{ cm}^{-1}$  in breadth. In the case where  $Q_p$  is not given by (15) but is broad and exists for several  $p$ , the equations that replace (18) and (19) are of greatly increased complexity. However, experience with ordinary parametric amplifiers shows that the performance which results with a broad pump spectrum may not be very different from that expected from an analysis which assumed a monochromatic pump; one might hope that that would be the case here also.

The most difficult errors to assess are those which arise from the lack of mode suppression or discrimination that was assumed in separating the infinite set of coupled mode equations (16) into the simple separated pairs (18) and (19).<sup>20</sup> Experimentally, this effect could be assessed by studying the SRS ladder from an essentially dispersionless gas for which index-matching would exist when all but longitudinal modes were suppressed (techniques are available to do this), and by comparing these results with results where all modes were allowed or encouraged. The former results should be the better predicted by the present analysis.

Observations of two SRS ladders stimulated simultaneously from two Raman-active vibrations of a single material (styrene) have been reported.<sup>7</sup> Not only was output observed at  $\omega_p \pm n\omega_1$  and  $\omega_p \pm m\omega_2$ , but also at the combination frequencies  $\omega_p \pm n\omega_1 \pm m\omega_2$  (where  $\omega_1$  and  $\omega_2$  are two vibration frequencies, and  $n$  and  $m$  are several small positive integers). To study this case, the vibrations which we have labelled by  $\mu$  in (2)-(9) must be extended to treat two classes or branches with different frequencies  $\omega_1$ ,  $\omega_2$ , widths  $b_1$  and  $b_2$ , and possibly shapes  $a_\mu(x)$ . The analysis proceeds as in Section III, and of course one finds that lines of one ladder can serve as pumps and form the basis of a ladder of the other frequency spacing, thus giving the combination lines.

Terhune first suggested that parametric amplification might be responsible for the first anti-Stokes line, and also by iteration for the other lines of the SRS ladder.<sup>4</sup> We have found that a kind of parametric amplification is indeed responsible, but because the non-linear element is resonant and lossy, it is a kind that does not satisfy the classical relationships, such as those of Manley and Rowe,<sup>21</sup> which are obeyed by ordinary parametric amplifiers. In Terhune's first written account of the SRS ladder processes he studies the tendency of a plane, monochromatic anti-Stokes wave to grow in space in the presence of plane, monochromatic Stokes and pump waves.<sup>11</sup> He finds that the anti-Stokes wave may grow or decline depending on relative time phases of the waves, and the clear evidence of phase-independent gain which we have found is absent.

Garmire *et al.* have studied how a plane monochromatic anti-Stokes wave gains and loses energy in time in the presence of plane monochromatic Stokes and pump waves.<sup>15</sup> They also find either gain or loss depending on the relative wave phases, and real gain at the fundamental anti-Stokes line is not apparent here. We have tried to connect these results

with ours by various methods of detailed balancing and averaging over the phases of the waves, but have failed. The index-matching conditions suggested by Garmire *et al.* agree closely with ours.

Zeiger *et al.*<sup>10</sup> have recently given a different, purely qualitative, explanation of the SRS ladder. They propose a "two-step" process in which pure SRS takes place followed by light scattering from the phonons that were created in the first process. They do not discuss the dynamics of their process but the kinematics or index-matching conditions which they deduce are in agreement with those of Garmire *et al.* and of this paper. However, we have found no analogue in our treatment to their idea that the effects can be considered as resulting from two processes in sequence. Neither have we been able to deduce any dynamical consequences from their idea which might be compared with our results.

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## THE PASSAGE OF RADIOACTIVE CARBON THROUGH FOLIAGE TO ROOT EXUDATES IN TOMATO PLANTS

G. RANGASWAMI AND T. S. GOVINDARAJAN

Microbiology Laboratory, Faculty of Agriculture, Annamalai Nagar

IT is now well established that plant roots excrete certain sugars, amino-acids, vitamins, etc.<sup>1-5</sup> The nature of these substances may vary with the plant species, age of plant and other cultural and environmental conditions. The biochemical basis for such excretions is not clearly understood as also the rate of movement of excretory substances from inside the plant tissue into the soil. It has become clear from the recent studies that there is a close relationship between micro-organisms and plant roots as observed in rhizosphere.<sup>1,2,4</sup> It is believed that both the micro-organisms and the plants get mutually benefited by such a relationship. With a view to examine the rate of movement of carbon supplied through the foliage, some studies were made and the results are presented here.

Uniformly labelled  $C^{14}$  D-glucose obtained from the Radio-chemical Centre, Amersham, England, was used in these studies. Tomato (*Lycopersicon esculentum* Mill.) seedlings grown on acid-washed quartz with modified Crone's solution<sup>6</sup> were taken up for the tracer work. 15-day-old seedlings were transplanted into the quartz in plastic cups and were allowed to establish. Then the plants were kept in dark for about 12 hr. 0.12 mg. of  $C^{14}$  D-glucose of 0.15 mc. activity (specific activity 440  $\mu$ c./mg. glucose) was eluted from the filter-paper on which it was obtained, with 2 ml. double distilled water and mixed with 100 ml. 15% AR-D-glucose solution and used for spraying the plants, care being taken to avoid contaminating the plastic cup and the quartz with the spray material.

At periodical intervals the plant parts were monitored using a Radiation Survey Meter Type GM 29, for the presence of activity. The root exudate samples from the treated and untreated check plants were collected at regular intervals, desalted following the procedure of Rovira<sup>6</sup> and examined for the radioactivity. The results are summarised in Table I.

These studies were repeated thrice using different sets of plants and the results were confirmed.

For the detection and identification of amino-acids, two-dimensional ascending paper chromatography was carried out with 25 cm.  $\times$  25 cm. Whatman No. 1 chromatography grade paper, using *n*-butanol-acetic acid-water (9 : 1 : 2.9) as solvent for the one direction and

TABLE I  
Comparison of the presence of radioactivity in  
the root exudates of tomato plants treated  
with  $C^{14}$  D-glucose

Sample	Average activity of 0.1 ml. of Sample: c.p.m.	Loss of activity : %
Spray solution ..	3600	..
Root exudate after:		
24 hours ..	2400	33 $\frac{1}{3}$
48 " ..	1200	66 $\frac{2}{3}$
72 " ..	1200	66 $\frac{2}{3}$
96 " ..	Trace	..

buffered phenol for the other and 0.5% ninhydrin in acetone as the colour-developing agent. The amino-acids isoleucine, leucine, phenylalanine, methionine, alanine, arginine and histidine were detected in the root exudate samples collected from both the check and treated plants. When the spots on the developed paper were monitored with Radiation Survey Meter Type RN 1258 A, activity could be distinctly detected in the spots corresponding to isoleucine, leucine, phenylalanine and methionine but not in the other spots. Glucose in the root exudate samples of both check and treated plants was detected by the ascending paper chromatographic method using *n*-butanol-acetic acid-water (5 : 1 : 4) as the solvent and benzidine-glacial acetic acid ethanol as the colour developer. Activity could be detected in the spots developed from the samples of the treated plants but not of the check plants. These results indicate that the carbon taken in by the plant through the foliage is either utilized for tissue build-up or thrown out within a short period of about 96 hr. Further studies to examine quantitatively the activity distribution at different time intervals are in progress.

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## LETTERS TO THE EDITOR

### SMALL ANGLE SCATTERING OF LOW ENERGY GAMMA-RAYS FROM ATOMIC ELECTRONS

THE coherent and incoherent scattering of gamma-rays at small angles have almost the same energy and it is not possible to distinguish between them energetically. So in order to measure the cross-section of either of the scatterings one has to determine the total scattering cross-section of the other. While reasonably accurate calculations for the small angle scattering of low energy gamma-rays are available for coherent scattering,<sup>1</sup> the well-known Klein-Nishina formula giving incoherent scattering cross-section for free electrons has to be modified at these angles and energies to take into account the effect of the binding of electrons to the atom and their motion and distribution within the atom.<sup>2</sup> The degree of modification will depend upon the nature of the scattering atom, the angle of scattering and the gamma-ray energy.

We have measured the incoherent scattering cross-section of 280 keV gamma-rays from four elements 'Z' ranging from 13 to 82 at five angles ranging from 4° to 10° with a view to examine the general behaviour of the deviations of the measured cross-sections from the Klein-Nishina values. The method of measuring the total scattering cross-section was the same as used earlier.<sup>3</sup> The 280 keV gamma-rays were obtained from Hg-203 radioactive source. The measurements were confined to angles between 4° and 10° because at angles greater than 10° the recoil momentum becomes so large that the scattering may be treated as that from free electron while at angles smaller than 4° the coherent scattering becomes much greater than the incoherent scattering so it is not possible to measure the cross-section for incoherent scattering with any significant accuracy. This difficulty has been encountered even in the present measurements with lead and the accuracy of the data below 8° is not satisfactory.

TABLE I

Scattering cross-sections of 280 keV gamma-rays  
(barns)

Element/ Angle (degrees)	Total cross-section (measured)	Coherent cross-section (calculated)	Incoherent cross-section (experimental)	Incoherent cross section (Klein-Nishina)	Percentage deviation
Aluminium					
4.1±0.5	1.74±0.03	0.82	0.92±0.03	1.027	-10±3
5.2±0.6	1.40±0.03	0.40	1.00±0.03	1.023	-2±3
6.4±0.8	1.24±0.04	0.23	1.01±0.04	1.018	-1±4
7.8±1.0	1.20±0.03	0.17	1.03±0.03	1.012	+2±3
10.2±2.0	1.18±0.03	0.12	1.06±0.03	0.99	+7±3
Iron					
4.1±0.5	6.19±0.10	4.40	1.79±0.10	2.05	-13±5
5.2±0.6	5.0±0.08	3.04	1.96±0.08	2.05	-4±4
6.4±0.8	4.19±0.07	2.25	1.94±0.07	2.04	-5±4
7.8±1.0	3.58±0.06	1.65	1.93±0.06	2.02	-5±3
10.2±2.0	2.81±0.06	0.98	1.83±0.06	1.99	-8±3
Copper					
4.1±0.5	7.7±0.10	5.8	1.9±0.10	2.29	-17±5
5.2±0.6	5.95±0.07	3.95	2.00±0.07	2.28	-12±3
6.4±0.8	4.89±0.07	2.85	2.04±0.07	2.27	-10±3.5
7.8±1.0	4.18±0.05	2.10	2.08±0.05	2.26	-8±2.5
10.2±2.0	3.28±0.07	1.25	2.03±0.07	2.23	-9±3.5
Lead					
4.1±0.5	110±1.5	110	..	6.47	..
5.2±0.6	74.5±1.4	76	..	6.45	..
6.4±0.8	53.6±0.8	52.0	..	6.42	..
7.8±1.0	38.3±0.7	34.2	4.1±0.7	6.38	-36±11
10.2±2.0	23.2±0.5	18.8	4.4±0.5	6.30	-30±8

The results are shown in Table I which gives the total (coherent + incoherent) measured cross-section, the calculated coherent cross-section,<sup>1</sup> the incoherent cross-section, the Klein-Nishina cross-section and the deviation of the measured cross-section from the Klein-Nishina value. The results show that at a given scattering angle and therefore for a given value of recoil momentum the deviation from the Klein-Nishina value increases as the atomic number or the binding energy of the electrons to the atom increases. For a given scatterer, the deviations from the Klein-Nishina values decrease as the scattering angle or the recoil momentum increases. These deviations may be explained as that when the scattering angle or the recoil momentum increases, the probability for the recoiling electron to leave the atom increases. When the recoil momentum is much larger than the momentum of the electron in its bound state, the recoiling electron is practically certain to leave the atom and the scattering cross-section under these conditions tends to attain the Klein-Nishina value.

Physics Department,  
Panjab University,  
Chandigarh, January 22, 1964.

S. ANAND.  
M. SINGH.  
B. S. SOOD.

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#### REGARDING THE 'E<sub>2</sub>' MECHANISM FOR THE CHROMIC ACID OXIDATION OF SECONDARY ALCOHOLS

We have taken note of a recent communication<sup>1</sup> in this journal wherein the authors have questioned the feasibility of the oxidation mechanism simulating the S<sub>N</sub><sup>2</sup> mechanism proposed earlier by us,<sup>2</sup> on the ground that a polarization of the C-H bond is unlikely with secondary alcohols and that attack by a water molecule is improbable on the highly shielded secondary carbon atom. We wish to stress here, that this mechanism envisages a nucleophilic attack on the carbon atom from which the strongly electrophilic oxidising agent is already pulling a hydride anion. What is more important in the mechanism is really the electrophilic pull by the cationic HCrO<sub>3</sub> and this should be enough to create a small positive charge on the

carbon atom, when the water molecule enters as a nucleophilic reagent and further aids in pushing the hydride anion. While there was the attractive alternative possibility that the lone pair of electrons on the oxygen of the -OH bonded to the carbon could do this 'nucleophilic' push, we feel that this, as also the alternative E<sub>2</sub> type of mechanism proposed by these authors, are probably unlikely for the following reasons:

(i) If the breaking of an -O-H bond were involved as part of the rate-controlling step, as has been postulated, there should be a pronounced isotope effect if the -OH group is substituted by an -O-D group. A mechanism, similar to the one proposed by these authors, has already been proposed for the oxidation of isopropyl alcohol by bromine, where a -CH<sub>3</sub> and an -O-H isotope effect (~2.94 and ~1.49 respectively) have been observed.<sup>3</sup> But no such -O-H isotope effect has actually been observed in the chromic acid oxidation of isopropyl alcohol where (CH<sub>3</sub>)<sub>2</sub>CHOD has been shown to be oxidised at the same rate as (CH<sub>3</sub>)<sub>2</sub>CHOH.<sup>4</sup>

(ii) Further this alternative was already considered by Westheimer and his associates as improbable on the basis that the CrO<sub>3</sub>-oxidation of isopropyl alcohol proceeds about 6 times as fast in D<sub>2</sub>O as it does in H<sub>2</sub>O.<sup>5</sup> They feel that if an -O-H bond were broken in the rate-controlling step of the reaction, then this bond would probably be cleaved more rapidly in H<sub>2</sub>O than in D<sub>2</sub>O with the result that the effect of D<sub>2</sub>O on the rate could scarcely be so large as that observed. The solvent isotope effect is thus also against the E<sub>2</sub> type of mechanism for the oxidation.

The mechanism first suggested, involving a concerted loss of a hydride anion from the alcohol,<sup>6,7</sup> still seems to us the best way of representing the oxidation, excepting for the fact that the high value of the kinetic isotope effect (4~10) seems to be too large for a cyclic hydrogen removal in a small ring and the hexavalent chromium species will have to present itself in such a way that while one part removes the secondary hydrogen as an anion, another part of it will have to remove a proton from the hydroxyl group synchronously. The simulated S<sub>N</sub><sup>2</sup> type of mechanism was put forward to obviate this.

Dept. of Chemistry, N. VENKATASUBRAMANIAN,  
Vivekananda College,  
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### ANOMALOUS MAGNETIC BEHAVIOUR OF THIOMALIC ACID COMPLEX OF NICKEL

NICKEL forms a deep violet coloured 1:3 complex with thiomalic acid at  $\text{pH} = 9.0 \pm 0.2$ . If the complex is square co-ordinated it should be invariably diamagnetic<sup>1</sup> and diamagnetic nickel complexes are red in colour. A consideration of the ligand field stabilisation<sup>2</sup> shows that stabilisation for octahedral complexes reaches a maximum at  $\text{Ni}^{++}$  ( $d^8$ ) while for tetrahedral complexes it is at  $\text{Co}^{++}$  ( $d^7$ ). So the complex under study is expected to be octahedral.

Thiomalic acid is a bidentate and hence the complex may be ionic with  $sp^3 d^2$  hybridization. Consequently the magnetic moment of  $\text{Ni}^{++}$  ion in this complex should be near about 3.2 B.M. as observed with ionic nickel salts.<sup>3</sup> But the violet colour of the complex raises doubt. For the study<sup>3</sup> of the absorption spectra of a number of violet Nickel complexes shows that the covalency factor<sup>4</sup>  $f^2$ , which measures the covalent character of the ion, tends to a value of 0.78 while for the green ionic salts it is 0.92. This smaller value of  $f^2$  in the violet complexes suggests some amount of covalent character and covalency will lower the magnetic moment from the ionic value.<sup>3</sup>

In order to test the above points we have measured the magnetic moment of this violet complex of Nickel with thiomalic acid in state of solution at  $\text{pH} = 9.0 \pm 0.2$  by Guoy method. Measurements gave the magnetic moment for  $\text{Ni}^{++}$  ion in the complex as 2.49 B.M. at  $28.5^\circ \text{C}$ .

Thus the complex is not square co-ordinated since it is paramagnetic. The moment value is lower than those in ionic salts which suggests a weak covalent bonding for the complex rather than ionic.

Details will be published elsewhere.

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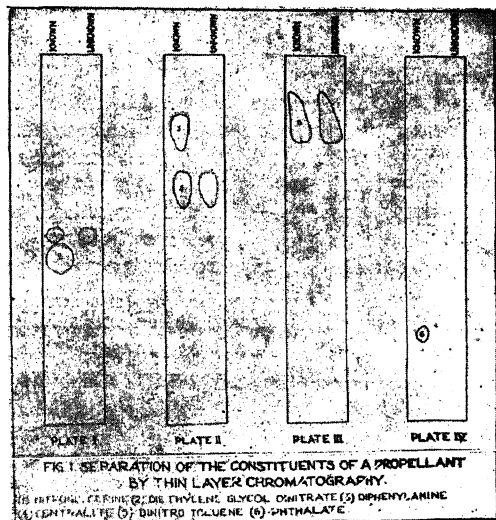
### ANALYSIS OF PROPELLANTS BY THIN LAYER CHROMATOGRAPHY

THE ether extract of a propellant contains organic nitrates, plasticizers, gelatinizers, stabilizers, flash reducers, etc., and its analysis by conventional chemical methods is time-consuming and requires considerable material. The methods involving infra-red spectroscopy<sup>1</sup> and column chromatography<sup>2</sup> are also not very convenient for a quick routine analysis. In view of its simplicity, small amount of material and lesser time required, thin layer chromatographic technique has been applied to the analysis of propellants.

The experimental procedure was the same as that described earlier<sup>3</sup> except that the chromatoplates were made with a 85:15 mixture of silica gel and plaster of Paris. For each propellant four plates were required for analysis. Suitable aliquots of the ether extract of the propellant and the ether solution of a known mixture were spotted 1 cm. apart on a line about 2 cm. from one end of each of the four plates. The known mixture consisted of nitrates of glycerine and glycol, dibutyl or diethyl phthalates, ethyl or methyl centralites, dinitrotoluene and diphenylamine. After developing the plates with 1:1 benzene:petroleum ether mixture, one plate was sprayed with 1% diphenylamine in concentrated sulphuric acid to indicate the presence and location of the nitrate esters of glycerine and glycol by blue spots. The second plate was sprayed with a 0.5% potassium dichromate in concentrated sulphuric acid which gives a blue spot with diphenylamine and a red spot with centralite. The third plate was treated with a spray of alcoholic potassium hydroxide (saturated) to give a brown spot with dinitrotoluene. The presence of phthalates was detected by treating the fourth plate with a spray of 1% resorcinol in concentrated sulphuric acid followed by heating for 5 minutes at  $130^\circ \text{C}$ . Finally the plate was sprayed with 5% aqueous sodium hydroxide and viewed under ultra-violet lamp. The phthalates give fluorescent

spots. Quite conveniently the plates 1 and 3 can be combined by first spraying with 6N sodium hydroxide to detect dinitrotoluene followed by spraying with 1% diphenylamine in concentrated sulphuric acid for locating nitrates of glycerine and glycol, thus reducing the number of plates required to three.

A typical analysis of an unknown propellant is shown in Fig. 1.



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Explosives Res. and S. K. SINHA.

Development Lab., A. K. BHALLA.\*

Poona-3, (Miss) S. K. SAHASRABUDHE.  
November 21, 1963. K. R. K. RAO.

\* Present Address: Terminal Ballistics Research Laboratory, Chandigarh.

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### A STUDY OF THE FELDSPARS FROM THE DECCAN TRAPS AROUND BHOPAL, M.P.

PREVIOUSLY the basalts near Bhopal were considered to belong to only one type, namely, fine-grained hyalitic. The work done by the author has revealed the presence of all the four textural types into which the Deccan traps have been divided by Washington, excepting that glass is present in all the types as reported by Fermor in the basalts of other areas in India.

In addition, there is a porphyritic type of basalt with zoned and twinned phenocrysts of feldspars.

The present note describes the feldspars that were studied from the three different flows of Bhopal. These are as follows:

(i) Basal flow of T. T. Nagar, (ii) Porphyritic flow forming the plateau south of Bhopal constituting the middle flow, and (iii) Non-porphyritic fine-grained flow capping the second flow in Bairagarh and forming the top flow south of Habiiganj railway station towards Misrod. There are three varieties of the basal flow, namely, (a) normal variety, (b) a variety with rounded inclusions of a coarse-grained basalt, and (c) a variety with abundant iron-ores.

(a) *Normal variety*.—This may be both medium-grained and coarse-grained. In the medium-grained variety the feldspars have a composition of  $An_{60}$  as determined from the maximum symmetrical extinction angle of  $31.5^\circ$ . They have an average length of 0.15 mm. The maximum symmetrical extinction angle recorded from the coarse-grained type is also the same and the feldspars average 0.2 mm. in length.

(b) In this, the coarse-grained and ophitic patches are present in a relatively fine-grained material. Plagioclase in these patches have length of 0.25 mm. The composition is  $An_{75}$ .

(c) In the iron-rich basal flow of Misrod, the feldspar crystals are shattered and the fractures have been filled up by glass. An untwinned zoned feldspar shows wavy extinction. There is a gradation from untwinned feldspar showing patchy extinction in bands. The twinning is therefore post-crystallisation as suggested by Vance (1961, p. 1110). The composition is  $An_{60}$ .

2. *Non-Porphyritic Flow*.—Plagioclase laths are generally of the same size as pyroxene. From the modal analysis pyroxene and plagioclase are found to be equal in amount. The average length of the plagioclase laths is 0.20 mm. The composition was found to be  $An_{64}$ .

3. *Porphyritic Flow*.—Plagioclase phenocrysts vary in size from 4.40 mm. to 3.30 mm. They show the maximum equal extinction angle of  $35^\circ$  which gives a composition  $An_{68}$ . The optic axial angle gave a composition of 66% An. In this flow, some feldspars are very large, most medium-grained, some are tiny elongated laths with forked terminations. Some medium-grained feldspars have also forked terminations.

Where pyroxenes are developed, a sub-ophitic texture is apparent, elsewhere feldspar is surrounded by glass. Interpenetration and cruciform twinning are present, and also twinning according to Carlsbad and albite laws. It may be noticed here that cruciform twinning is very rare in Deccan Trap basalt (Agashe, 1957, p. 72). Glomeroporphyritic aggregates have also been observed.



FIG. 1. Glomeroporphyritic aggregate of feldspar phenocrysts with interpenetration twinning.

*Twinning and Zoning.*—The twinned feldspars are also zoned (Vance, 1962, p. 758), but this goes against the view of Emmons and Mann (1961, p. 52).

Oscillatory and normal zoning as well as synneusis structure (Hills, 1936) are observed. During the course of zoned crystallization, the crystals have developed cracks, with introduction of other mineral matter along the cracks. When the cracks have crossed the entire crystal, zoning near the periphery has died out somewhere inside the crystal, not far from the periphery, giving rise to synneusis structure. In some, the zoning is delicately oscillatory. The most satisfactory explanation of this type of zoning has been given by Hills (1936) and this has been accepted by Vance. The diffusion of anorthite material in a zone immediately adjacent to the growing crystal leads to the crystallization of a relatively more calcic plagioclase in this zone where a certain degree of supersaturation has been reached. This also leads to the formation of the next outer zone of relatively more sodic composition. A fresh diffusion of new anorthitic material causes a repetition of the sequence.

The author's thanks are due to Prof. S. C. Chatterjee, Prof. D. K. Chakravarti, and Shri

Jajati Bhattacharjee (of G.S.I.) for their help and useful suggestions.

Vikram University,  
Department of Geology,  
Vigyan Bhawan,  
Bhopal, October 7, 1963.

A. C. CHATTERJEE.

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#### OCCURRENCE OF THE PELECYPOD GENUS *DIPLOSCHIZA* CONRAD IN THE CRETACEOUS ROCKS OF TRICHINOPOLY, INDIA

IN a recent field investigation of the Cretaceous rocks of Trichinopoly (now Tiruchirapalli), Madras, the author collected a large number of specimens belonging to the pelecypod genus *Diploschiza* Conrad. These fossils occur in an arenaceous shaly bed about 2.5 km. north-west of Kunnam Village (Long. E 79° 1' 30" and Lat. N 11° 13' 45"). They were collected from three localities along the strike of the bed: (i) a well excavation about 150 meters N 30° E of Asur Bridge on the Ariyalur-Perambalur highway; (ii) a place about 300 meters south of the 9th milestone on the same highway; and (iii) a place about 1 km. N 25° E of Odiyam village. The thickness of the bed varies from 30' to 40', striking approximately in NE-SW direction and dipping at very low angles towards SE. The shale at places contains intercalations of concretionary sandstone.

The genus *Diploschiza* is characterised by broadly ovate, lamellar shells with convex right valve and concave left valve. The shell is attached by the umbo of the right valve to a substratum, generally other shells such as those of *Tubulostium* or *Ostrea*. Attached left valves are not uncommon. The length and breadth of the shells vary between 8 and 15 mm. and thickness 4 to 7 mm. In one case the length is as much as 20 mm. The umbones are thin, truncated, frequently broken off becoming perforated. Hinge is straight, but generally broken in the middle and edentulous. Inner surface of the valves are characterised by sharp, irregularly spaced, often branching striæ, which in some adult shells become obsolete, especially in those which have an elaborate external ornamentation.

There are no indications of any muscular scars on the inner surface even in well-preserved shells, which agrees with the observation of Stephenson.<sup>1</sup> The outer surface is variously ornamented, but commonly with a smooth surface crossed by concentric, often slightly raised growth lines. In some cases, ornamentation consists of radial lines, crenulations or spines.

Further examination of these fossils revealed that, based on the nature of the external ornamentation of the shells, four species could be distinguished (Fig. 1), which for the purposes

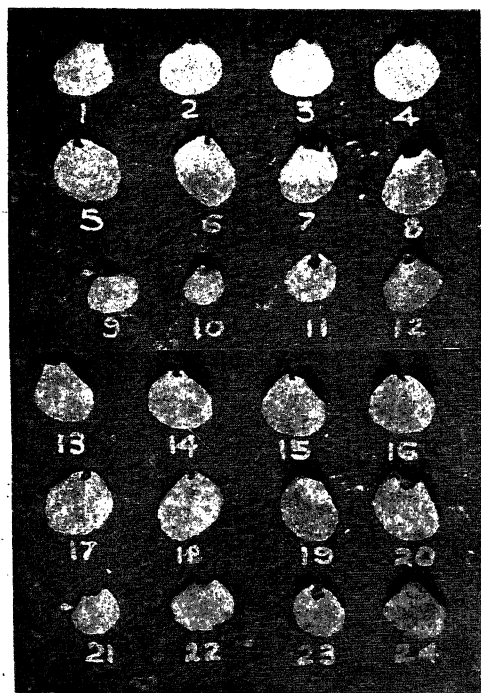


FIG. 1. I Row: 1-4. Exterior of right valves of *Diploschiza* sp. A; II Row: 5-6. Exterior of left valves of *Diploschiza* sp. A; 7-8. Exterior of right valves of *Diploschiza* sp. C. III Row: 9-10. Exterior of right valves of *Diploschiza* sp. B; 11-12. Exterior of right valves of *Diploschiza* sp. C. IV Row: 13-16. Interior of the right valves of *Diploschiza* sp. A. V Row: 17-18. Interior of the left valves of *Diploschiza* sp. A; 19-20. Exterior of the left valves of *Diploschiza* sp. D. VI Row: 21-22. Interior of left valves of *Diploschiza* sp. B; 23. Interior of right valve of *Diploschiza* sp. C; 24. Exterior of left valve of *Diploschiza* sp. C.

of the present paper are designated as *Diploschiza* sp. A, sp. B, sp. C and sp. D. The author had the opportunity to compare the present specimens with some specimens of *Diploschiza cretacea* Conrad (U.S.N.M. 16995) from its type locality in Alabama, and found that the species A closely resembled *D. cretacea*,<sup>2</sup> which is the

type species of the genus and widely distributed in the Gulf Coast region of U.S.<sup>3</sup> No significant differences in characters were observed between the two species except in the nature and strength of the internal striae. The other three species appear to be new ones.

Though *Diploschiza* is known to be widely distributed in the Campanian-Maestrichtian horizons of Gulf Coast of U.S., this is the very first report on the occurrence of this genus in India. In fact, except for Stephenson's identification<sup>1-2</sup> of Wood's *Dimyodon sigillina* (Woodward<sup>4</sup>) from the Senonian of England as belonging to the genus *Diploschiza*, the genus is being reported for the first time outside the Gulf Coast region of U.S.

All the earlier described species of *Diploschiza* are confined to Campanian-Maestrichtian horizons—*Diploschiza cretacea* and its varieties are from the middle of *Exogyra ponderosa* zone of U.S.,<sup>2</sup> *D. melleni* occurs in the uppermost beds of Selma Chalk of Gulf Coast<sup>1</sup> while the type specimens of *D. sigillina* came from the *Belemnitella mucronate* zone of England.<sup>2</sup> But the Indian representatives of the genus occur in the Middle Utatur stage, in that the beds that occur above and below the *Diploschiza*-bearing bed contain the characteristic fossil *Calycoceras newboldi* (Kossmat) of the family Acanthoceratidae. On the basis of this fossil and other ammonoids the Middle Utatur stage has been considered to be Cenomanian in age.<sup>5-8</sup> Hence the Indian occurrence, besides being the only undoubted one outside the Gulf Coast of U.S., is also the first one in a stratigraphical horizon much older than Campanian, that is, in the beds of Cenomanian age.

Further, the occurrence in the Cretaceous of South India, in the Cenomanian period, of a species of *Diploschiza* closely resembling a species (*D. cretacea*) occurring in the Campanian of U.S. is interesting in that it might throw light on the migration of the genus.

The work was carried out in the Department of Geology, Banaras Hindu University, during the author's stay there. The author is grateful to Prof. Rajnath for his guidance and providing facilities, and to Shri S. Varadarajan for many valuable suggestions. The author is also indebted to Dr. N. F. Sohl and the authorities of the U.S. National Museum, Smithsonian Institution, for lending some specimens of *Diploschiza cretacea* for comparison.

Bombay,  
October 15, 1963.

N. K. RAO.\*

\* Present Address : Scientific Officer, Ore Dressing Section, Atomic Energy Establishment, Trombay, Bombay-74.

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### ON THE OCCURRENCE OF FISHES OF THE FAMILY SCHINDLERIIDAE IN THE INDIAN OCEAN

THE family Schindleriidae with the genus *Schindleria* was created by Giltay<sup>1</sup> to accommodate *Hemirhamphus praematurus* and *H. pietschmanni* described from the Pacific by Schindler<sup>2,3</sup> who presumed them to be sexually mature larval hemirhamphids.<sup>4</sup> Bruun<sup>5</sup> and Schultz<sup>6</sup> have subsequently recorded the collection of *S. praematurus* from the Pacific and the latter has placed the family Schindleriidae in a sub-order Schindleriina. According to Bruun<sup>5</sup> *Schindleria* could be considered as the lightest of all known vertebrates whereas the gobies, *Pandaka pygmaea* and *Mistichthys luzonensis* though shorter are comparatively heavier than the former. All the previous records of *Schindleria* have been from the Pacific, with *S. praematurus* from widely separated areas, viz., Hawaiian Islands, New Guinea, Tahiti, Samoa, Tasman Sea, off Sydney and Grafton (Australia) and Bikini, while *S. pietschmanni* has been known only from the Hawaiian Islands.

A study of the larval and juvenile fishes collected from the Laccadive Archipelago revealed the presence of specimens less than 20 mm. resembling larval fishes but with mature gonads which on further examination turned out to be *Schindleria*. Both the species are represented in the collections and there are in all 81 specimens of *S. praematurus* ranging from 11.7-20.5 mm. in total length and 8 specimens of *S. pietschmanni* ranging from 8.2-15.1 mm. in total length. As in the Pacific, the former appears to be comparatively more abundant and widely distributed in the Laccadive area. This is the first record of their occurrence in the Indian Ocean Region and it is most likely that these should have a wider distribution than known hitherto but their small size might have

prevented their detection from among larval fishes. It is hoped that the participants of the International Indian Ocean Expedition will be on the lookout for this interesting genus of fishes.

Detailed notes on the material studied by us are being published elsewhere.

Central Marine Fisheries  
Research Institute,  
Mandapam Camp,  
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S. JONES.  
M. KUMARAN.

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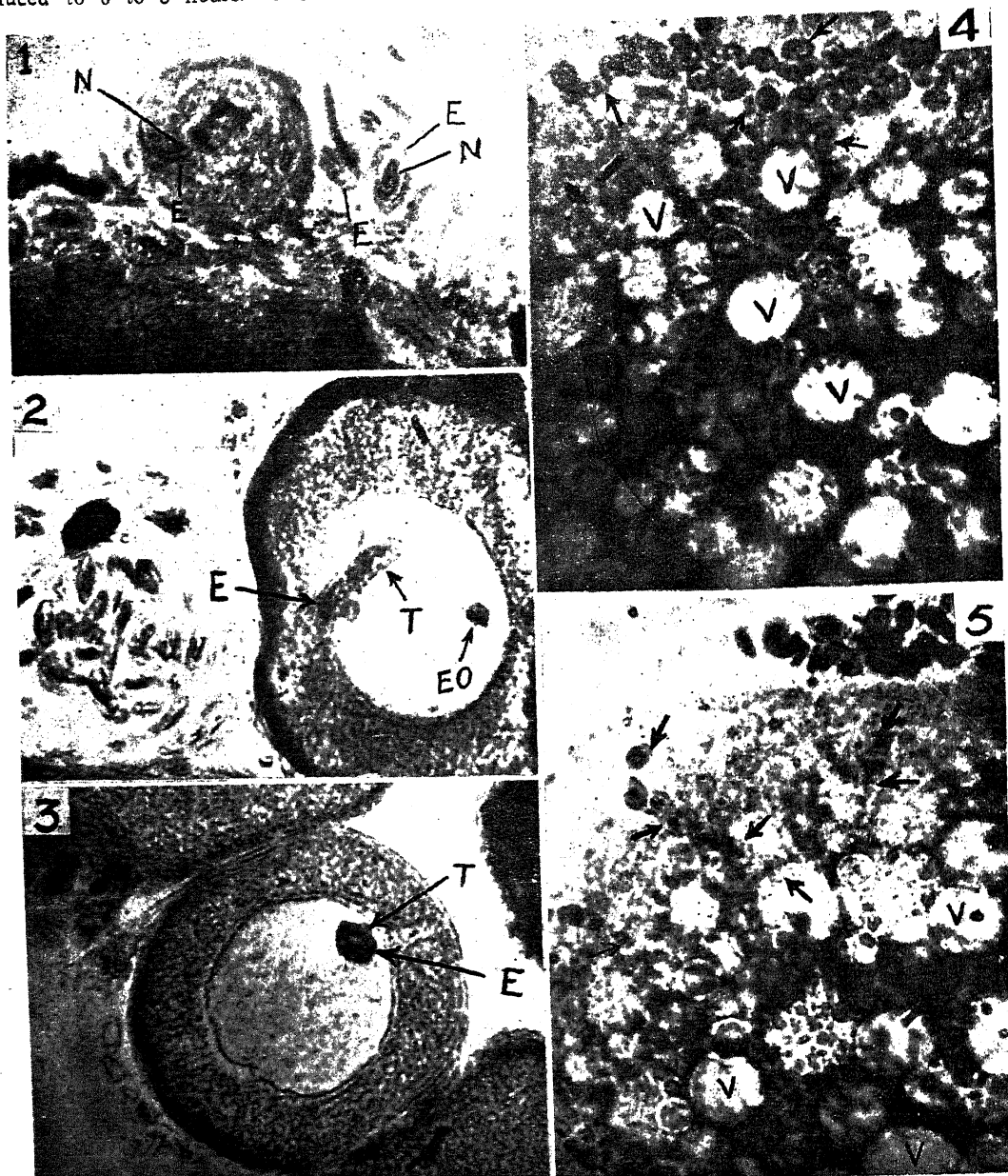
### ON THE NATURE OF NUTRIENT MATERIALS OF THE GROWING OOCYTES OF THE FISH

LITTLE is known about the source and nature of nutrient materials and their mode of transport into the growing oocytes of vertebrates.<sup>1</sup> The author has observed, in the case of a teleostean fish, *Trichogaster fasciatus*, and of the common frog, *Rana tigrina*, that nourishment, dissolved in the plasma, is brought from the blood capillaries to the growing oocytes by means of a series of temporary cytoplasmic tubules,<sup>3</sup> and has demonstrated, by means of histochemical methods, the presence of haemoglobin, benzidine peroxidase granules and haemosiderin in the cytoplasm as well as in the germinal vesicle of the oocytes of *Trichogaster fasciatus*.<sup>2</sup> Since the growing oocytes of the fish have no source of intake of these specific iron compounds other than the erythrocytes, it was inferred that the red blood corpuscles, like those in the case of the frog, must enter the piscine oocyte. In this report, the evidence, which bears out the above inference, is presented.

The oocytes of *Trichogaster fasciatus* and *Heteropneustes fossilis* were studied at all stages of their growth. Pieces of ovaries were fixed in alcoholic Bouin's and Susa's fluids. These were embedded in paraffin and sectioned 2 to 5  $\mu$ . thick. Sections, prepared with Bouin's fixative, were stained with Heidenhain's iron-alum haematoxylin and eosine. Sections, prepared with Susa's fixative were treated with trypsin, washed thoroughly, then, treated with ribonuclease, washed and finally submitted to



Baker's acid hæmatin or AH test.<sup>4</sup> The time for borax ferricyanide differentiation was reduced to 6 to 8 hours. The sections were dehydrated by passing through two changes of acetone, cleared in xylol and mounted in neutral balsam.



FIGS. 1-5. Fig. 1. A section of a small oocyte of *Heteropneustes fossilis* showing the nucleus, N, of an erythrocyte, E, inside the ooplasm. Iron-alum hæmatoxylin and eosine,  $\times 450$ . Fig. 2. A section of an oocyte of *H. fossilis* showing a tubular structure, T, containing an erythrocyte, E, projecting into the nucleoplasm where an eosinophilic body, EO, is visible,  $\times 450$ . Fig. 3. An erythrocyte, E, with a central clear space, is seen in the germinal vesicle of *Trichogaster fasciatus*. The red cell is still attached to a shrinking tubular structure (marked with arrow). Iron-alum hæmatoxylin and eosine staining,  $\times 450$ . Fig. 4. A section of a large oocyte of *T. fasciatus*. Erythrocytes are marked with arrows. Fixation: Susa's, trypsin and ribonuclease digestion followed by the AH test,  $\times 450$ . Fig. 5. A section of a bigger oocyte of *T. fasciatus*. Note the erythrocytes (marked with arrows) in relation with the vacuoles, V. Fixation and treatment as in Fig. 4,  $\times 450$ .



Examination of these preparations showed that the erythrocytes enter the piscine oocyte at all stages of its growth. At the beginning of the growth phase, the oocyte is found closely associated with the blood capillaries and vessels and the red blood corpuscles are found in its contact as well as entering singly into the egg cytoplasm and the germinal vesicle (Figs. 1, 2 and 3). To reach the nucleus of an immature oocyte, an erythrocyte seems to pass through a short, tubular projection from the ooplasm into the germinal vesicle (Fig. 2). When it enters the nucleus, the tubular projection appears to shrink away, thus setting the red blood cell free in the nucleoplasm (Fig. 3). Inside the egg nucleus the erythrocyte undergoes relatively rapid disintegration. Its nucleus immediately loses basophilia and looks like an empty hole and the cell body gradually breaks up into smaller eosinophilic parts. Some granular or globular parts in the nucleoplasm, however, become stained with basic dyes. In the bigger oocytes, which are filled with oily droplets, the erythrocytes could not be seen in preparations fixed with Bouin's fluid and stained with iron-alum hæmatoxylin and eosine. The result of the second method was very helpful. In these sections erythrocytes, forming "rouleaux" within the egg cytoplasm, are easily identified. They are distinguishable from other components of the egg by means of their nuclei being jet black and their outline clearly defined (Figs. 4 and 5). In the relatively smaller eggs, erythrocytes are found in the nucleus as well as in association with the developing ooplasmic vacuoles but in the bigger oocytes, they are seen mostly in and around these enlarging vacuoles.

As these red cells are nucleated, each nucleus contains DNA. It may, therefore, be inferred that when the erythrocytes disintegrate inside the ooplasm or germinal vesicle they make valuable contribution of their own DNA to the growing egg.

The author is indebted to the Patna University for financial assistance, to Prof. S. Keshava

for encouragement and to Mr. J. N. Varma for help in the preparation of the illustration.

Post-graduate NIRMALA CHATTERJEE.  
Dept. of Zoology,  
Patna University,  
Patna-5 (Bihar), July 29, 1963.

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#### DISEASE INCIDENCE AND YIELD OF COCONUT IN RELATION TO FOLIAR SPIRAL

RECENTLY attention has been focused on the leaf arrangement of coconut palm and its correlation with the productivity of the palm.<sup>1-3</sup>

Our observations on 740 palms aged about 13 years in three groups show that 47.7% of the population have their leaves arranged in the left-handed direction and 52.3% in the right-handed direction.

Incidence of leaf rot and root (wilt) diseases in relation to the leaf arrangement of the palms was to the extent of 43.3% among the lefts and 47.4% among the rights. Final data are summarised in Table I.

Data on the annual average yield of palms also do not indicate any perceptible variation in relation to the orientation of the foliar spiral.

Similarly a study of the yield per tree of 191 palms which include both healthy and diseased, failed to show any correlation between the foliar spiral, the general health of the palms and their yields.

Thus the disposition of the foliar spiral in coconut appears to have no influence on the incidence of diseases as well as yield of the coconut palm. This is only to be expected, since the foliar arrangement is not a genetical character (Davis, 1962 b).

TABLE I  
General condition and yield of palms in relation to foliar spiral—yield as number of nuts per tree per year

Condition of palm		Left spiral					Right spiral				
		No.	Per cent.	1960	1961	1962	No.	Per cent.	1960	1961	1962
Healthy	..	201	56.6	..	..	..	202	52.4	..	..	..
Wilt affected	..	94	26.4	..	..	..	137	35.5	..	..	..
Leaf rot	..	60	16.9	..	..	..	46	11.9	..	..	..
		355	47.7	36.6	36.3	37.8	385	52.3	36.7	38.3	37.2

Our thanks are due to Shri K. N. Sahasranaman for supplying the yield data of the palms.

C.C.R.S., Kayangulam,  
July 11, 1963.

K. RADHA.  
K. M. PANDALAI.

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## TWO UREDINICOLOUS DEUTERO-MYCETOUS HYPERPARASITES FROM BHOPAL (INDIA)

WHILE making phytopathological collections from Raisen Road forest, Bhopal, during October 1962, the author collected the following two hyperparasites of which the first is being presented here as a new record and the second with a new host record.

1. *Cephalosporium* sp. hyperparasite on teleutosori of *Puccinia anodæ* Sydo. on *Kydia calycina* Roxb.

The teleutosori are completely covered by the mycelium of the hyperparasite which disintegrates the rust sori gradually. The hyperparasite enters teleutospores through germ pores or stalk and forms branched haustoria within it (Fig. 1A).

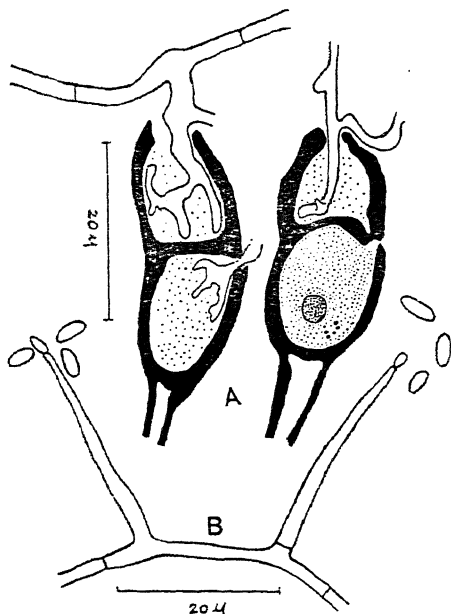


FIG. 1. (A) Teleutospores with haustoria of hyperparasite (B) Hypha, conidiophores and conidia (as seen in a water mount).

The characteristics of the fungus are as described below :

Hyphae hyaline, branched, septate, prostrate, measuring up to  $3.44 \mu$  in diameter, and giving rise to slender, erect, simple, hyaline conidiophores at intervals (Fig. 1). Conidiophores measuring  $20.88-45.24 \mu$  in length gradually taper from base to apex and bear one-celled oval or ellipsoidal straight or curved hyaline conidia measuring  $2.46 \times 4.63 \mu$  ( $2.49-8.30 \mu \times 1.66-3.32 \mu$ ). Conidia collect in a slime drop at the tip of conidiophores and form a head measuring up to  $34.7 \mu$  in diameter.

Previously *Cephalosporium acremonium* Corda. has been reported by Hassebrauk<sup>1-3</sup> and Prasad<sup>4</sup> as parasitising *Puccinia graminis tritici*, *P. glumerum*, *P. lolii*, *P. anomala* and *P. heterospora*. So far as the author is aware, this is the first record of *Cephalosporium* sp. as a hyperparasite on *Puccinia anodæ*.

2. *Tuberculina persicina* (Ditm.) Sacc. hyperparasite on teleutosori of *Puccinia heterospora* Berk. and Curt. on *Sida veronicifolia* Lam. —*Puccinia heterospora* is the new host record for the fungus.

The voucher specimen has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew, under No. 96553 for *Cephalosporium* sp. and No. 96552 for *Tuberculina persicina*.

The author expresses his grateful thanks to Prof. O. N. Handoo for facilities and encouragement. My special thanks are due to the Director, Dr. Elphick, Dr. Deighton, and Dr. G. F. Laundon of C.M.I., Kew, for help in the identification of the pathogens.

Pathology Section,  
Department of Botany,  
Motilal Vigyan Mahavidyalaya,  
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H. N. SATYA.

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## NANOMITRIUM TENERUM (BRUCH.) LINDB.— A NEW RECORD FOR INDIA

IN an earlier communication<sup>1</sup> mosses were excluded from the enumeration of cryptogams of Bhopal. In this note, the remaining cryptogams since encountered, together with the mosses of this area are given. In the latter a moss *Nanomitrium tenerum*, as far as known, is a new record for India.\*

TABLE I

Type	Locality	Habitat
CHRYSOIDEAE (Chrysomelidae)		
MARCHANTIALES		
<i>Taraxacum officinale</i> L.	Dehra Dun, India	On a grassy field along a road
<i>Plantago lanceolata</i> L.	Dehra Dun, India	On a grassy field along a road
<i>Plantago lanceolata</i> L.	Dehra Dun, India	On a grassy field along a road
THURACEAE		
<i>Thalictrum flavum</i> L.	Dehra Dun, India	On a grassy field along a road
<i>Thalictrum flavum</i> L.	Dehra Dun, India	On a grassy field along a road

TABLE II

Chrysomelidae (Chrysomelidae)

Type	Locality	Habitat	Remarks
PSEUDOCYTOIDEAE			
1. <i>Leptocryptus</i> sp.	Dehra Dun, India	On a grassy field along a road	A small, slender species with a long, narrow leaf
2. <i>Leptocryptus</i> sp.	Dehra Dun, India	On a grassy field along a road	A larger species with a broad, ovate leaf
POTYLOIDEAE			
3. <i>Gymnatomella nemoralis</i> H. & E.	Dehra Dun, India	On a grassy field along a road	
4. <i>Semiothisa orientalis</i> (Weber)	Wardha, India	On a grassy field along a road	A small, slender species with a long, narrow leaf
5. <i>Hydrophilus fuscus</i> (H. & E.)	Dehra Dun, India	On a grassy field along a road	
EPHEMEROIDEAE			
6. <i>Neomantodea tenuis</i> (H. & E.)	Dehra Dun, India	On a grassy field along a road	A small, slender species with a long, narrow leaf
ARCHIDIPTERA			
7. <i>Archidium indicum</i> (L.)	Dehra Dun, India	On a grassy field along a road	Associated with <i>Neomantodea tenuis</i> and noted for its very large spores
BRYACEAE			
8. <i>Bryum pseudoternatum</i> Schwaegr.	Dehra Dun, India	On a grassy field along a road	Also reported from the garden of the author
9. <i>Bryum pseudoternatum</i> Schwaegr.	Dehra Dun, India	On a grassy field along a road	
10. <i>Anomolopus indicum</i> (L.)	Dehra Dun, India	On a grassy field along a road	
ENTODONTACEAE			
11. <i>Entodon</i> sp.	Dehra Dun, India	On a grassy field along a road	

† Thanks are due to Prof. M. S. Agarwal for placing the material at my disposal.

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Botany Department, O. N. HASBANI  
M.V. Mahavidyalaya, SUDHA SHrivastava  
Bhopal, August 10, 1963

\* I am thankful to Shri K. S. Chopra for drawing my attention to it.

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## INDUCED POLYPLOIDY IN THE ENGLISH BLACK MINT

*Mentha piperata* which yields the peppermint oil of commerce is considered to be a hybrid of *M. spicata* the spear mint and *M. aquatica* the water mint by Schuthoff (1929), who found 2n = 36 in both the species. There are two well-known forms of the species the so-called "white mint" *M. piperata* var. *officinalis* known as the Methan mint of England, which is a smaller plant and less hardy than the English Black mint, and *M. piperata* var. *salvatica* which is more extensively grown in the middle west of USA as a source of

peppermint oil. These varieties were introduced at the Regional Research Laboratory, Jammu, from Kew in 1952 and are now being successfully grown in Srinagar (Kapoor and Chopra, 1962). The chromosome number of these Kew plants were found to be  $2n = 36$  in the case of the White mint and  $2n = 72$  in the Black mint (Figs. 1 and 2). Glotov (1940)

I treated the suckers of the Black mint received from Kew in 1952 with 0.1% solution of Colchicine in January 1963 for twenty-four hours. Clones with larger leaves and more robust habit were produced (Fig. 3). These had the characteristic large stomata found in Colchicine tetraploids and also had  $2n = 144$  chromosome (Fig. 4).

My thanks are due to Dr. E. K. Janaki Ammal for her keen interest and encouragement during this work.

Regional Research Laboratory,  
Canal Road, Jammu-Tawi,  
August 26, 1963.

S. N. SOBTI.



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FIGS. 1-4. Fig. 1. *Mentha piperita* var. *officinalis*,  $2n = 36$ ,  $\times 3,700$ . Fig. 2. *Mentha piperita* var. *vulgaris*,  $2n = 72$ ,  $\times 3,700$ . Fig. 3. *Mentha piperita* var. *vulgaris*,  $2n = 144$ ,  $\times 3,700$ . Fig. 4. *Mentha piperita* var. *vulgaris*, Diploid and Tetraploid plants.

reported  $2n = 36$ ,  $2n = 64$  for *M. piperata* and higher numbers than these have been reported by Ruttle and Nagao (see *Chromosome Atlas for Cultivated Plants*, Darlington and E. K. Janaki Ammal, 1945).

In 1940 Glotov experimentally produced a Black mint with chromosome number  $2n = 128$  from his  $2n = 64$  plant.

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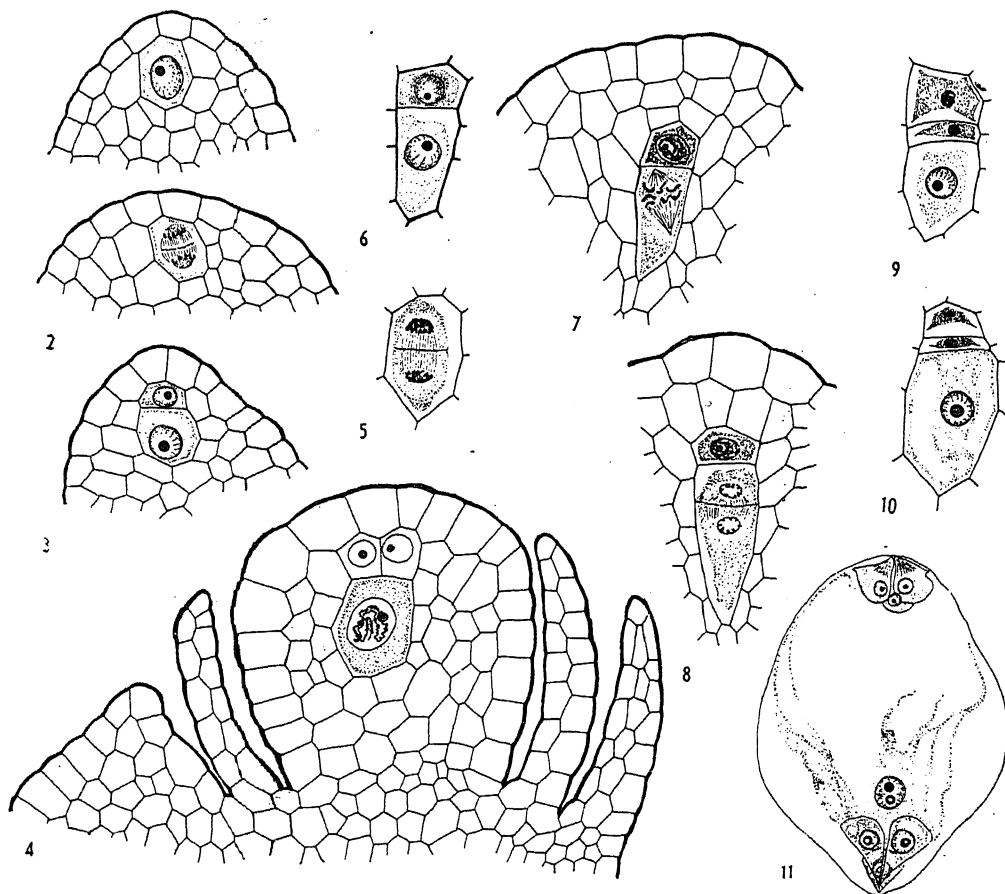
#### OVULE AND EMBRYOSAC OF *PANCRATIUM MARITIMUM* L.,— A REINVESTIGATION

According to Shadovsky<sup>1</sup> the archesporial cell arises in the third layer of the nucellus and the embryosac development conforms to the *Allium* type in *Pancratium maritimum*. He states that the upper dyad cell gives rise to two megaspores which degenerate while the lower dyad cell develops into the 8-nucleate embryosac. His figures representing the dyad stage and the triad stage do not, however, give a clear idea as to which of the two dyad cells has actually divided to give rise to the triad stage consisting of one undivided dyad cell and two megaspores. Therefore, a critical reinvestigation of *P. maritimum* has been undertaken to verify his statements and the results are reported here.

The numerous anatropous, bitegmic and crassinucellate ovules are borne on axile placentae in the tricarpeal, trilocular and inferior ovary. The primary archesporial cell differentiates in the sub-epidermal layer before the integumentary primordia are initiated (Fig. 1). The archesporial cell cuts off a parietal cell (Figs. 2, 3). The megaspore mother cell undergoes the first meiotic division (Fig. 4) giving rise to two dyad cells of about equal size (Fig. 5). The lower dyad cell enlarges while the upper dyad cell begins to degenerate (Fig. 6). It is not the upper dyad cell that divides but it is really the lower dyad cell that undergoes the second meiotic division to give rise to two megaspores of which the upper is smaller (Figs. 7, 8). A row of three

cells is thus formed the uppermost cell being an undivided dyad cell (Fig. 9). The lower megaspore is functional and becomes vacuolated (Fig. 10). Three free nuclear divisions follow resulting in an 8-nucleate embryosac. The eight nuclei organize themselves into the three-celled egg apparatus, three antipodal cells which are vacuolated and two polar nuclei which fuse

My sincere thanks are due to Professor J. Venkateswarlu for guidance and helpful suggestions, and to Professor P. Maheshwari for literature. I am greatly indebted to Professor A. Fernandes, Coimbra, Portugal, for material. Thanks are also due to the Government of India for the award of a Research Training Fellowship tenable at the Andhra University, Waltair.



FIGS. 1-11. Fig. 1. L.s. ovule showing the hypodermal archesporial cell. Fig. 2. Same showing telophase in the archesporial cell leading to the formation of a parietal cell. Fig. 3. Same showing the megaspore mother cell and the parietal cell. Fig. 4. Same showing the megaspore mother cell and the parietal cell that has divided periclinally. Fig. 5. Formation of dyad cells. Fig. 6. Dyad cells. Fig. 7. L.s. nucellus showing the parietal layer, the disintegrating upper dyad cell and the lower dyad cell in metaphase of meiosis II. Fig. 8. Same showing the formation of a triad. Fig. 9. Triad. Fig. 10. Triad showing the functional megaspore. Fig. 11. Mature embryo-sac. Figs. 1-10,  $\times 400$ ; Fig. 11,  $\times 120$ .)

in the vicinity of the antipodal cells to give rise to the secondary nucleus (Fig. 11).

From the above it is clear that the archesporial cell is undoubtedly hypodermal and that the embryosac development conforms to the *Polygonum* type and not to the *Allium* type as stated by Shadowsky.

Biology Department,  
A.N.R., College,  
Gudivada, August 6, 1963.

B. S. M. DUTT.

### SOME INTERESTING OBSERVATIONS IN *EURYALE FEROX* SALISB.

*Euryale*, of the family Nymphaeaceae, was once represented by many species throughout the world. Now it is survived by a single species in parts of Japan, North America, Europe and India.

*Euryale* is a densely prickly aquatic annual with a thick perennating root-stock. Leaves are alternate, long-petioled, peltate and prickled beneath. Partially submerged epigynous flowers are violet in colour. There are a few erect sepals, many petals and stamens. The ovary is eight-chambered bearing a few large ovules on parietal placentae. Seeds are roasted and eaten.

The material was collected from Alwar, Rajasthan, in August and September 1962.

The broad flat stamens have laminar and partially embedded tetralocular microsporangia. The anther wall consists of an epidermis, an endothecium, two middle layers and a tapetum. The spherical pollen grains are shed at three-celled stage. The ovule is anatropous, bitegmic and crassinucellate (Fig. 1) with a conspicuous

further only anticlinally forming one layer of parietal tissue. It encloses the developing gametophyte but degenerates rather early. The inner integument forms the micropyle. The chalazal nucellus is very massive and its cells at the base of the chalaza retain meristematic activity for quite a long time. Megaspore tetrads are usually T-shaped (Fig. 2).

Embryo-sac is of Polygonum type (Fig. 3). After fertilization, however, it enlarges due to an encroachment of its antipodal region on the massive chalazal tissue.

Four outgrowths from the funiculus grow as an aril (Fig. 1). It is pulpy at maturity and appears as four valve-like structures at the chalazal region of the seed.

The scanty endosperm is vacuolated and appears depleted. It is consumed rather early in the development of the seed. The massive chalazal nucellus or the perisperm compensates for the absence of endosperm. Some of its cells tend to become 2-nucleate. However, its peripheral and basal cells remain small and uninucleate. The medianly disposed cells of the chalaza are full of starch grains; their number being 50-70 in a cell. Towards the micropylar end, however, their number is considerably lower.

Like the embryo-sac, embryo is also quite small as compared to the size of the seed. Suspensor is absent (Figs. 4-6). Cotyledons are saucer-shaped (Fig. 7). Shoot apex is well organised; tunica is two-layered. Two to three leaf primordia are seen in the mature embryo (Fig. 8). Polyembryony is recorded. The two or three embryos seen in a seed are almost at the same stage of development. These embryos possess cotyledons and leaf primordia.

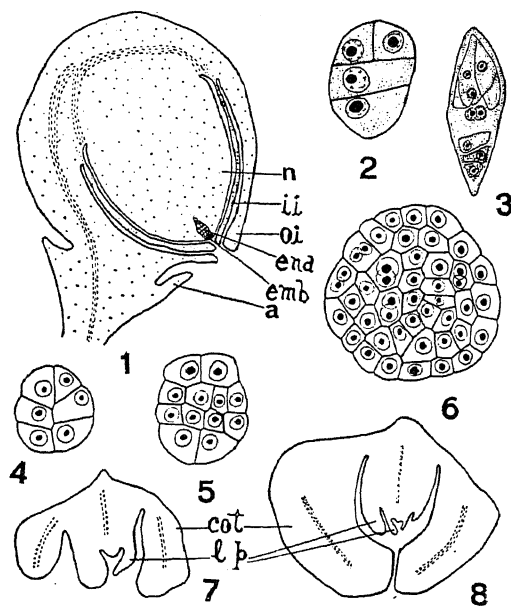
The testa is stony and its outer surface is smooth. Tegmen is papery and two-layered except at the micropylar end where it is three-layered. The thick pericarp possesses prickles on its outer surface.

Features like flat broad stamens with laminar embedded microsporangia remote from the margin, minute size of the embryo-sac and embryo in comparison to the size of the ovule and seed and massive perisperm indicate the primitive nature of *Euryale*.

The author wishes to express her thankful appreciation to Dr. B. Tiagi for valuable discussions and Prof. C. V. Subramanian for encouragement.

Department of Botany,  
University of Rajasthan,  
Jaipur, August 21, 1963,

PUSHPA KHANNA,



FIGS. 1-8. *Euryale ferox*. Fig. 1. Anatropous ovule showing vascular supply and aril. Fig. 2. T-shaped tetrad. Fig. 3. Embryo-sac. Figs. 4-6 Embryos without suspensor. Figs. 7-8. Mature embryos showing saucer-shaped cotyledons and leaf primordia. (a, aril; cot, cotyledon; emb, embryo; end, endosperm; li, inner integument; l p, leaf primordium; n, nucellus; oi, outer integument.)

vascular strand. The hypodermal archesporial cell cuts off an outer parietal cell, which divides

# SOME OBSERVATIONS ON CONCHOCELIS-PHASE FROM VISAKHAPATNAM COAST

By a series of well-planned culture experiments, Drew<sup>1,2</sup> has demonstrated that the shell-boring alga, *Conchocelis rosea*, described by Batters<sup>3</sup> in 1892, is not an autonomous species, but a phase in the life-history of *Porphyra*. Kurogi<sup>4</sup> has shown that this phase occurs in the life-history of four Japanese species of *Porphyra*. It has also been reported from a variety of empty marine shells and other habitats from Norway, Sweden, Denmark, France, U.K., Black Sea Coast, etc., on the shores of which species of *Porphyra* are known to occur. *Conchocelis*-phases of different species of *Porphyra* appear to be similar, therefore. Although the latter alga has been reported from Madras by Boergesen<sup>5</sup> in 1937 and by Sreeramulu<sup>6</sup> in 1952 from Visakhapatnam, this is the first record of *Conchocelis*-phase from our country.

During his visits to Visakhapatnam coast in June 1962 and 1963, the author has collected several empty shells of *Cellana*, *Ostrea*, etc., containing the phase from the intertidal zone. The following observations based on 1962 collection agree with those of Rosenvinge<sup>7</sup> and Drew and Richards<sup>8</sup> who have described the phase from Denmark and France respectively.

Shells containing *Conchocelis*-phase show on their inner surface rusty-brown or purple patches which are small and scattered in early stages, becoming larger in shells of longer standing due to the fusion of several small patches. A shell of *Ostrea* collected in 1962 is shown in Fig. 1. Small pieces of infected shells were decalcified and the resultant filaments were observed after squashing.

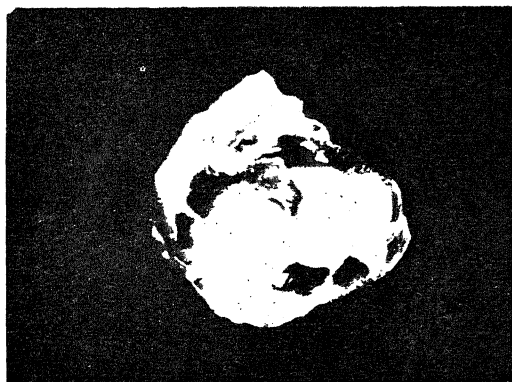


FIG. 1. Shell of *Ostrea* containing *Conchocelis*-phase collected in June 1962. Natural size.

The filaments at the centre of mat are very closely interwoven, while those at its periphery are comparatively loose, their terminal portions having a characteristic straight or undulating course (Fig. 2, A). Branching and cross-walls are rare in the terminal region, but are common elsewhere. The filaments are narrow, 1.5-4  $\mu$  in diameter, and the contents are scanty. Fusions between filaments have been observed occasionally. Stages in the development of fertile cell-rows (Fig. 2, B-E) are seen in large numbers between the richly branched and sparsely branched portions of the plant. The initial stages of fertile cell-rows are aseptate, but later stages consist of 4-7 cells and are generally 10-15  $\mu$  broad and 20-75  $\mu$  long. In addition, plantlets in different stages of development have also been met with (Fig. 2, F). The cells of plantlets have thick walls and the chromatophores fill the cells completely (cf. Drew,<sup>2</sup> Text-Fig. 4. b and Plate XII, 3).

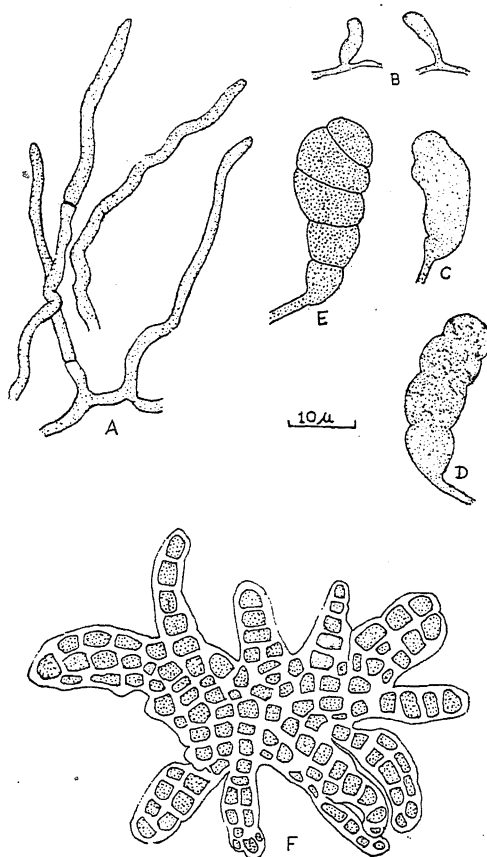


FIG. 2. *Conchocelis*-phase. (A) A few peripheral filaments. (B-E) Stages in the development of fertile cell-rows. (F) A plantlet.

Recently Umamaheswara Rao and Sreeramulu<sup>9</sup> have observed on Visakhapatnam coast that young plants of *P. vietnamensis* frequently appear on *Cellana* and *Chthamalus* and have suggested that *Conchocelis*-phase may occur on this coast also. It can be concluded, therefore, that the phase now described is that of *P. vietnamensis* and that the life-history of the alga follows the same general pattern as in other parts of the world. As elsewhere, the macroscopic phase occurs for a few months in the year and the microscopic phase presumably perennates in the shells during the unfavourable seasons. It should be mentioned, however, that the origin of the leafy thallus from *Conchocelis*-phase is not precisely understood. While Kurogi<sup>4</sup> claims that the spores from it produced the leafy form, Drew<sup>10</sup> has demonstrated that they reduplicate the *Conchocelis*-phase. Whether the Indian *Conchocelis* reproduces one way or the other will remain a matter of conjecture until suitable culture experiments are carried out.

Dept. of Botany, C. S. PRAKASA RAO.  
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#### OVERCOMING INTERSPECIFIC INCOMPATIBILITY IN *LYCOPERSICON*

SEVERAL attempts have been made in the past to cross the cultivated species of tomato, *Lycopersicon esculentum* with its wild relatives *L. peruvianum* and *L. glandulosum*, mainly for the purpose of transferring the genes for resistance to viruses possessed by the latter to the cultivated strains. Smith<sup>1</sup> was able to achieve the cross *L. esculentum* × *L. peruvianum* by means of culturing the few heart-shaped hybrid embryos noted by him. Choudhury<sup>2</sup> also attempted embryo culture, but the hybrids obtained by him were sterile. More recently, Nirk<sup>3</sup> obtained by grafting of parent material prior to crossing 8 self-fertile interspecific

hybrids between *L. esculentum* and *L. peruvianum* var. *dentatum*.

A study of the relative efficacy of grafting, hormone application, mixed pollination and use of irradiated pollen in ensuring success in the cross *L. esculentum* × *L. peruvianum* and *L. esculentum* × *L. glandulosum* was undertaken and the results are presented in this note.

For grafting, 2-3-week old plants were selected, the leaves and branch shoots pruned away from the stock, and the scion of about 2 inches length was cleft-grafted to the stock using a tight bandage of alkathene tape to secure the union. The grafted plants were protected under shade and at later stages supported by means of bamboo stakes. As reported by Nirk<sup>3</sup> the union of *esculentum* (scion) on *peruvianum* (stock) was less successful whereas the reciprocal was easier to make. However, by the use of seedling-grafts,<sup>5</sup> this difficulty could be overcome to a large extent. In this method, the seeds of *esculentum* parent were germinated on moist filter-paper in a petri dish and the tiny seedlings at the cotyledon-stage were directly inserted along with the primary root into clefts of *peruvianum* stocks. Since the latter has a tendency for diffuse branching, each branch could be used to make a seedling-graft, so that on every single plant of *peruvianum* anything between 3 to 5 grafts of *esculentum* seedling-scions could be established without difficulty.

In another experiment, grafted *L. esculentum* was crossed with *L. peruvianum* whose pollen was irradiated with varying doses of X-rays. This combined treatment had earlier resulted in the successful crossing of the two jute species by Swaminathan, Iyer and Sulbha.<sup>4</sup> In the present work, 5 true hybrids from the cross *L. esculentum* var. *marglobe* × *L. peruvianum* var. *E.C. 493*, and one hybrid from the cross *L. esculentum* × *L. glandulosum* were obtained in this way. It may be pointed out here that Elizabeth Günther<sup>6</sup> also attempted grafting prior to crossing *L. esculentum* with *L. peruvianum* but the hybrid embryos aborted at the globular stage itself. Sztejn<sup>7</sup> was also unable to secure the cross between *L. esculentum* with *L. glandulosum* by the method of repeated grafting before crossing.

The application of the hormones  $\alpha$ -naphthalene-acetic acid and 3-indole-acetic acid was tried. Flowers emasculated the previous evening were pollinated the following morning and then the pedicels were wrapped with a small piece of cotton soaked in an aqueous solution



TABLE I  
Efficacy of different techniques

Cross	Treatment	No. of flowers pollinated	No. of plump seeds obtained	No. of real hybrids obtained
<i>L. esculentum</i> × <i>L. glandulosum</i>	Untreated control	400	0	0
<i>L. esculentum</i> × <i>L. peruvianum</i>	"	1000	0	0
<i>L. esculentum</i> var. <i>marglobe</i> × <i>L. peruvianum</i> var. <i>E.C. 492</i>	Mixed pollination	300	24 average plump seeds per fruit	8
<i>L. esculentum</i> var. <i>P. ruby</i> × <i>L. peruvianum</i> var. <i>E.C. 2795</i>	"	100	25	3
<i>L. esculentum</i> var. <i>meeruti</i> × <i>L. peruvianum</i> var. <i>E.C. 492</i>	Hormone application 3-I.A.A. (300 p.p.m.)	100	4	1
<i>L. esculentum</i> var. <i>marglobe</i> × <i>L. peruvianum</i> var. <i>E.C. 492</i>	Grafting and pollen irradiation	150	9	5
<i>L. esculentum</i> × <i>L. glandulosum</i>	"	50	4	1

of the hormone. By this method, Islam and Rashid<sup>8</sup> were able to make the cross between *Corchorus olitorius* and *C. capsularis*. During the present study higher doses of  $\alpha$ -N.A.A. led only to callus formation at the flower pedicels, whereas 3-I.A.A. (300 p.p.m.) treatment yielded one fertile hybrid from the cross *L. esculentum* var. *meeruti* × *L. peruvianum* var. *E.C. 492*.

The third important technique of mixed pollination successfully employed here to overcome the incompatibility barrier in *Lycopersicum* was essentially the one described by Ter-Avanesyan<sup>9</sup> in *Gossypium* crosses. There are two variations of this method and both were tried. In the first, the emasculated buds were pollinated immediately on the same evening, with an unlimited amount of pollen from the male parent. Next morning, a second dose of unlimited amount of same pollen was applied, followed at noon (about 20 hours after emasculation) by a mixture of equal parts of maternal and paternal pollen.

In the second method, buds emasculated the previous evening were pollinated on the following morning with a restricted amount (approximately 20 grains) of pollen from the maternal parent followed by the application, 3 hours later, of unlimited quantities of pollen from the male parent.

These methods gave 8 true hybrids out of an average of 24 plumpseeds/fruit from 300 pollinations made in the cross *L. esculentum* var.

*marglobe* × *L. peruvianum* var. *E.C. 492*, and 3 more hybrids resulted out of an average of 25 plumpseeds/fruit from 100 pollinations made between *L. esculentum* var. *Pusa-ruby* (♀) and *L. peruvianum* var. *E.C. 2795* (♂). Straight crosses made without any of the above treatments served as controls. Of these 1,000 matings between *L. esculentum* and *L. peruvianum* and 400 between the former and *L. glandulosum* did not yield even a single plumpseed. The results have been summarised in Table I. The hybrid nature of the seeds obtained has been established by studying both the F<sub>1</sub> and F<sub>2</sub> progenies. Several interesting recombinants occur in the hybrids (Fig. 1).



FIG. 1. Fruit clusters of (1) *Lycopersicon esculentum* var. *marglobe*, (2) *Lycopersicon peruvianum* var. *dentatum*, and (3) F<sub>1</sub> Hybrid.

The author is deeply grateful to Dr. M. S. Swaminathan for suggesting the problem and for his guidance at all stages of this study.

Division of Botany, (MRS.) REHANA MAJID.  
Ind. Agric. Res. Inst.,  
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# INHERITANCE OF GLUME COLOUR AND PUBESCENCE IN INTER-VARIETAL CROSSES OF *TRITICUM DICOCUM*

KADAM<sup>1</sup> AND SRINIVASAN<sup>2</sup> have described the mode of inheritance of glume pubescence in certain varieties of *T. dicocum*. The authors are not aware of any reports on the inheritance of black glume colour.

In a cross between these two varieties, all the  $F_1$  plants had deep black colour on practically the entire glume area. This condition is distinctly different from that of either parent. The  $F_2$  and  $F_3$  data are given in Table I.

It is clear from the  $F_2$  segregation that two factor pairs are in operation. E. 4325 has got one dominant factor for black-striped glumes, while H.W. 20 possesses another factor for white glumes. As a result of the interaction of these two factors, the colour of the glume changes to deep black throughout the glumes. This hypothesis is confirmed by the breeding behaviour in the  $F_3$  generation. Such complementation of loci producing a wild character, when together is suggestive that mutation at either locus, particularly the one which is an intensifier of the striped condition to uniform black colour might be responsible for the origin of the colourless or white glumes.

Three crosses were studied for the mode of inheritance of glume pubescence. The pubescent glumed parents are H.W. 40, H.W. 26 and H.W. 1, while N.P. 200 and H.W. 20 were the glabrous parents. Pubescence was dominant in the  $F_1$ . The  $F_2$  and  $F_3$  data are presented in Table II.

It is clear from the data that glume pubescence is controlled by a single dominant gene.

TABLE I

Segregation for glume colour in the  $F_2$  and  $F_3$  progenies of the cross E. 4325  $\times$  H.W. 20

Generation	Observed number of $F_2$ plants/ $F_3$ families				$X^2$	P value	Expected ratio
	Striped	Complete black	white	Segregating			
$F_2$	260	598	197	..	0.0916	0.98-0.95	4 : 9 : 3
$F_3$	10	6	3	41	3.49	0.50-0.30	4 : 1 : 1 : 10

TABLE II

Segregation of glume pubescence in the  $F_2$  and  $F_3$  generations

Sl. No.	Material	Observed number of F <sub>2</sub> plants/F <sub>3</sub> families			X <sup>2</sup>	P value	Expected ratio	
		Pubescent Segregation 3 : 1		Glabrous				
1	<u>N.P. 200 × H.W. 40</u>	..	137	..	49	0.351	0.70-0.50	3 : 1
	F <sub>2</sub>	..	12	29	10	1.126	0.70-0.50	1 : 2 : 1
2	<u>N.P. 200 × H.W. 26</u>	..	255	..	91	0.312	0.70-0.50	3 : 1
	F <sub>2</sub>	..	9	28	16	2.170	0.50-0.30	1 : 2 : 1
3	<u>H.W. 1 × H.W. 20</u>	..	126	..	46	0.280	0.70-0.50	3 : 1
	F <sub>2</sub>	..	13	23	16	1.040	0.70-0.50	1 : 2 : 1

E. 4325 is a variety from Ethiopia, having glumes with thin black stripes extending longitudinally. H.W. 20 is pure for white glumes.

Division of Botany, V. K. SRINIVASAN.  
Ind. Agric. Res. Inst., T. S. PADMANABHAN.  
New Delhi-12, August 14, 1963.

## REVIEWS

**Mass Spectrometry of Organic Ions.** Edited by F. W. McLafferty. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xii + 730. Price \$ 24.00.

Every student of physics and of chemistry is aware of the immensely important role played by the mass spectrometer in the emergence of present-day knowledge regarding the ultimate structure of matter. Indeed, the progressive development of that instrument to higher and higher degrees of precision has enabled the investigators to penetrate deeper and deeper into the fundamental problems of those sciences.

The book under review is the conjoint work of sixteen contributors and is devoted to surveying the methods and results of the application of the mass spectrometer to the field of organic chemistry. To indicate the wide coverage of the subject contained in this volume of 730 pages (including author and subject index) it appears best to list the titles of the individual articles contained in it. (1) Quasi-Equilibrium Theory of Mass-Spectra, (2) Ion-Molecule Reactions, (3) Appearance-Potential Data of Organic Molecules, (4) Negative Ion Mass-Spectra, (5) Mass-Spectra of Organic Radicals, (6) Mass-Spectrometry of Ions from Electric Discharges, Flames and Other Sources, (7) Decompositions and Rearrangements of Organic Ions, (8) High Resolution Mass-Spectrometry, (9) Mass-Spectrometry of Long-Chain Esters, (10) Application to Natural Products and Other Problems in Organic Chemistry, (12) The Molecular Structure of Petroleum and (13) Mass-Spectra of Terpenes. It will be evident from this list that the basic and practical aspects of the subject are both given due attention. It will also be obvious that the exposition of their personal experiences in the respective fields by the contributors would be of the highest possible interest to those working in the same fields of chemical technology, irrespective of whether or not they are actually concerned with using the mass-spectrometer in their day-to-day activities. It will be clear that the contents of the volume would also be of profound interest to the academically-minded organic chemist.

With so many excellent articles to choose from, it may appear invidious to select a few for special mention or comment. The reviewer feels however that this would be entirely justified in the case of the eighth article in the

series on High Resolution Mass-Spectrometry by Saunders and Williams, both members of the staff of the I.C.I. at Manchester in England. The article interested the reviewer particularly as it contains an admirably clear account of the experimental techniques and the application of high resolution mass-spectrometry to numerous substances, especially those of relatively simple structure and composition. The article well illustrates the remark made earlier in this review how enormously the increase of precision in mass-spectrometry enlarges the usefulness of that technique.

C. V. R.

**Topics in Chemical Physics.** By Alfred Prock and Gladys Mc. Conkey. (Elsevier Publishing Co., P.O. Box 211, Amsterdam), 1963. Pp. vi + 277. Price 63 sh.

Professor Debye's name is familiar to all students of chemical physics by reason of the fundamental contributions made by him to the subject. The most familiar of these is his well-known treatment of the influence of permanent molecular dipoles on the dielectric behaviour of gases and of condensed phases. Familiar also is the Debye-Huckel theory of strong electrolytes. More recently also, Prof. Debye interested himself in the scattering of light by solution of substances consisting of molecules of large size. The book under review is a report of a series of lectures dealing with these fields delivered by him at the Harvard University. The treatment of the subject in each case is systematic and has a didactic purpose. The book will therefore be very welcome in academic circles.

The reviewer has found the chapter on "The Statistical Method" to be particularly illuminating. The following remark appearing in it which we take the liberty of quoting here is typical of Prof. Debye's critical attitude of mind. "The population expression we have just discussed appears in the so-called Bose-Einstein statistics, which we have used in our development of an expression for partition function. If instead, the assumption is made that one particle state can hold one particle only, the results are associated with the name Fermi-Dirac statistics. The names are really misnomers, for they give the impression that they represent different statistical methods. Actually, the statistical

method is the same for the Fermi-Dirac statistics as for the Bose-Einstein—it is just the stipulation concerning the assignment of particles that is different.”

C. V. R.

**Russian Tracts on Advanced Mathematics and Physics (Vol. XIII): Effect of Ionizing Radiation on High Polymers.** By T. S. Nikitina, E. V. Zhuravskaya and A. S. Kuzminsky. (Gordon and Breach, Science Publishers, New York-11, N.Y.), 1963. Pp. vi + 90. Price \$ 4.95.

Advances on high-polymers, both on the theoretical and on the technical sides, have been very rapid and polymer products are coming into increasing use in modern life. A subject of practical interest to polymer chemists and technologists is the effect of ionizing radiations such as X-rays, gamma-rays, slow and fast-moving neutrons, and charged particles, on these macromolecular substances. For it is well known that these radiations profoundly affect the structure of the macromolecules, producing such changes as cross-linking of the molecular chains, alterations in the number and nature of double bonds, and degradation of molecules. Of course, the changes effected depend on the dosage and nature of the irradiation. Regarding the structural changes involved it may be generalised that polymers which contain at least one atom of hydrogen per atom of carbon of the chain are cross-linked upon irradiation, whereas polymers with quaternary carbon atoms in the chain get degraded with the formation of volatile products and molecules of smaller chain length.

The chemical changes that polymers undergo upon irradiation are accompanied by changes in the physical properties also, such as density, elasticity, thermal expansion, degree of crystallinity, electrical conductivity, etc., which are of great practical significance.

The publication under review which is Vol. XIII of the *Russian Tracts on Advanced Mathematics and Physics*, published by the House of Gordon and Breach, is the English translation of the original Russian compilation on the subject. It is essentially a literature survey on effects of ionizing radiations on high polymers, and the review covers the literature published in the USSR and abroad up to the end of 1958.

A short first chapter forms the introduction giving the reader a general idea of interaction of radiation with matter, dosimetry, units employed in measuring irradiation, and sources

of irradiation. The second chapter deals with radiochemical processes in polymers, and the third chapter with results of investigation in particular materials. There is an Appendix of several tables giving useful information about different types of elastomers and the effects of irradiation on them.

The tract is a very useful one, and it is not surprising that such a lot of information is compacted into so thin a volume because the type used in print is very small; and the 3-page loose folder containing more than 200 references is the limit!

A. S. G.

**Introduction to the Theory of Integration.** By T. H. Hildebrandt. (Academic Press, New York and London), 1963. Pp. 385. Price \$14.00.

The book consists of the following eleven chapters:—

**Chapter 1: A General Theory of Limits.**—The theory of integration depends on the limits of a variety of types and hence this chapter is devoted to the presentation of the general theory of limits as developed by Moore and Smith. The concept of filters introduced by Bourbaki group and the basic properties of linear normed complete spaces are also included.

**Chapter 2: Riemannian Type of Integration.**—The chapter starts with the discussion of the properties of integrals of functions of intervals including the functions of bounded variation. The author then introduces Riemann-Stieltjes integral for the case of any two general functions and then devotes considerable discussion to the integrals in which the function with respect to which the integration is performed is of bounded variation. The chapter ends with the study of Riemann-Stieltjes integrals defined on infinite intervals.

**Chapter 3: Integrals of Riemann Type of Functions of Intervals in Two or Higher Dimension.**—This chapter develops mostly the theory of Riemann-Stieltjes double integrals as the discussion to higher dimension needs only the formal generalisation.

**Chapter 4: Sets.**—This chapter deals with the definitions, operations and manipulations of sets and classes of sets and forms the basis of the chapters to follow.

**Chapter 5: Content and Measure.**—This chapter deals with the content and general Lebesgue measure of linear sets,  $\alpha$ -measure and measurability of sets in Euclidean Space of higher dimension and ends with the discussion of abstract measure theory.

**Chapter 6: Measurable Functions.**—This chapter deals with the definition and properties of measurable functions including Lusin's Theorem on approximations to measurable functions.

**Chapter 7: Lebesgue-Stieltjes Integration.**—This chapter deals with the theories of Lebesgue, Young and Lebesgue-Stieltjes integration and includes at the end integration with respect to functions of bounded variation and unbounded measure functions.

**Chapter 8: Class of Measurable and Integrable Functions.**—This chapter discusses the properties of  $L^1$  and  $L^p$  classes of function with emphasis on  $L^2$  class.

**Chapter 9: Other Methods of Defining the Class of Lebesgue Integrable Functions—Abstract Integrals.**—Here first the theorems are established which prove that class  $L^1$  may be regarded as the completion of a metric space by Cauchy Sequences or as the extension of the class of continuous functions on  $(a, b)$  by adding the class of functions which are limits of uniformly bounded sequences of continuous functions excepting for a  $v$  ( $a$ )-null set. The latter part of the chapter is devoted to the theory of  $L$ - $S$  integrals on an abstract set.

**Chapter 10: Product Measures—Iterated Integrals.**—Fubini Theorem.

**Chapter 11: Derivatives and Integrals.**—This chapter deals with the properties of derivatives and establishes the fundamental theorem for Lebesgue integrals under certain conditions.

The book is the outgrowth of lectures by the author on this subject during a period more than a quarter of a century. The clear and systematic treatment of the subject bears testimony to the deep thinking of the author on the subject. The reviewer appreciates very much that the book is self-contained inasmuch as it does not assume more than some important properties of functions of a real variable and a basic knowledge of topological properties of real line, continuous functions, functions of bounded variation, derivatives and Riemann integrals. The inclusion of a large number of illustrative examples and problems for solution by the reader makes it an excellent text-book on the subject for M.A. and M.Sc. students of the Indian Universities.

The author has indicated, wherever necessary, the sources where more advanced treatment can be obtained.

The reviewer has great pleasure in recommending this carefully written and beautifully brought-out book as a valuable treatise on this subject.

P. L. BHATNAGAR.

**Advances in Heterocyclic Chemistry, Vol. I.**  
Edited by A. R. Katritzky. (Academic Press, Inc., New York and London), 1963. Pp. xi + 476. Price \$ 15.00.

This is an excellent review of the advances in some branches of heterocyclic chemistry. The topics discussed in this volume, are: Recent Advances in the Chemistry of Thiophenes (S. Gronowitz); Reactions of Acetylenecarboxylic Acids and their Esters with Nitrogen-containing Heterocyclic Compounds (R. M. Acheson); Heterocyclic Pseudo-bases (D. Beke); Aza-Analogs of Pyrimidine and Purine Bases of Nucleic Acids (J. Gut); Quinazolines (W. L. F. Armarego); Proto-tropic Tautomerism of Heterocyclic Compounds, I, General Discussion and Methods of Study, II, Six-membered Rings (A. R. Katritzky and J. M. Lagowski). Modern concepts and physical methods used in dealing with the topics can be well illustrated by citing the method of discussion of Thiophenes. After mentioning the present-day difficulty of arriving at a molecular structure for thiophene and substituted thiophenes by quantum mechanical calculations, the author enumerates their resonance structures whose existence is then substantiated by extensive NMR data supplemented by U.V., I.R. and microwave spectral data of the compounds. Further discussion on preparative methods includes the newer ones. The properties of thiophenes as aromatic compounds is then dealt with in the light of the above discussion.

Heterocyclic chemistry is a very wide field and hence selection of a few topics may depend on the interests of the particular editor and has to be arbitrary. There are several good series of volumes which deal with the basic chemistry in these branches; the present *advances* review the selected topics, in the light of more up-to-date knowledge and hence is a very useful and welcome publication. The printing and get-up of the book is very good and errors are rare.

C. R. NARAYANAN.

#### Books Received

*The Soybean.* Edited by A. G. Norman. (Academic Press, New York), 1963. Pp. x + 239. Price \$ 6.00.

*Inorganic Complexes.* By Chr. Klixbull Jorgensen. (Academic Press, New York), 1963. Pp. v + 220. Price \$ 2.00.

*International Geophysics Series (Vol. 6)—Thermodynamics of Clouds.* By L. Dufour and R. Defay. (Academic Press, New York), 1963. Pp. xiii + 255. Price \$ 10.00.

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## SCIENCE NOTES AND NEWS

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### Award of Research Degrees

The Andhra University has awarded the D.Sc. Degree in Nuclear Physics to Shri D. L. Sastry for his thesis entitled "Studies on Neutron Capture, Gamma-Rays"; Ph.D. Degree in Botany to Shri A. Ramalingam for his thesis entitled "Studies on the Air-Spora of a Paddy Field near Visakhapatnam in 1960 and 1961"; and the Ph.D. Degree in Zoology to Mr. M. Babu Rao for his thesis entitled "Studies on Clupeoid Fishes of Godavari Estuary".

### Central Public Health Engineering Research Institute

The Central Public Health Engineering Research Institute, Nagpur, will hold a symposium on "Problems in Water Treatment" during November 1964. Interested people may send 2 copies of full papers by July 31, 1964 to Dr. N. U. Rao, Nehru Marg, Nagpur-3.

### Symposium on "Utilisation of Metallurgical Wastes"

The Symposium, earlier announced (*Curr. Sci.*, 1963, 32, 434) on "Utilisation of Metallurgical Wastes", will be held in the National Metallurgical Laboratory, Jamshedpur, on March 10, 11, 12 and 13, 1964.

### The Institute of Physics and the Physical Society—Conference on Many-Body Problems

A short Conference on many-body problems in physics and chemistry is being arranged by the Institute of Physics and the Physical Society in the University of Manchester on 22, 23 and 24 September, 1964. The object of the Conference will be to review recent progress, and above all to highlight points of similarity between the concepts and methods in different fields. The sessions will be held on the following topics: Atomic structure and spectra, solid state physics, molecular structure and excited states, nuclear structure, nuclear excited states, scattering and reaction theory, polymers, liquids and phase transitions.

Offers of contributions are welcome and each offer should be accompanied by three copies of an abstract (100-200 words), which should reach the Conference Secretary, Dr. A.

Herzenberg, Theoretical Physics Department, The University, Manchester-13, *not later than 24 June, 1964*. The complete papers should reach *not later than 3 August, 1964*.

Further details will be available in May 1964 from the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London S.W. 1.

### Endeavour Prizes

Prizes totalling 100 guineas are offered by Imperial Chemical Industries Limited, Publishers of the International Scientific Review, *Endeavour*, for essays submitted on any one of the following scientific subjects.

- (1) Dissemination of scientific knowledge.
- (2) Physics of the Sun, (3) Structure of large molecules, (4) Chemistry of the noble gases.
- (5) The role of taxonomy in modern biology.
- (6) Human adaptability.

The essays, which must be in English and typewritten, should not exceed 4,000 words in length, and only one entry is permitted from each competitor. The competition is restricted to younger scientists who are under 25 years of age.

All entries should be addressed to The Deputy Secretary, British Association for the Advancement of Science, 3, Sanctuary Buildings, Great Smith Street, London S.W. 1, so as to reach him before 1st June 1964.

### N.R.P.R.A. Silver Jubilee Conference

The Natural Rubber Producers' Research Association (N.R.P.R.A.) is celebrating its Silver Jubilee with a Scientific Conference to be held in Cambridge from 7th to 9th April 1964. The Chairman of the Conference is Dr. L. Bateman, Controller of Rubber Research for the Malayan Rubber Fund Board.

The programme will include plenary lectures by Sir Harry Melville, Professor Herman Mark and Professor James Bonner, and two discussion symposia entitled: (A) "Ultrastructure and Metabolism of *Hevea latex*" and (B) "Chemical Structure and Mechanical Properties of Vulcanized Rubber".

*Aeginetia indica* Linn.—Further Record of Its Hosts

Shri K. M. Vaid, Forest Research Institute, Dehra Dun, writes: In the forests around Dehra Dun, although *Aeginetia indica* L. is found most commonly parasitising on *Dioscorea bulbifera* L., it is occasionally to be found growing on the roots of *Costus speciosus* Sm. and *Hedychium coronarium* Koen. (Scitamineæ). In addition, it was found parasitising on the rhizomes of garden *Canna* (Scitamineæ) in the house compound.

A Few Additional Characters for *Cautleya lutea* Royle

Messrs. M. R. Halim and S. K. Katagi of the Botanical Survey of India, Shillong, write: A specimen (Bor 21211) of *Cautleya* (Scitamineæ) collected from Naga Hills was studied and its identification confirmed at Kew, London, as *Cautleya lutea* Royle. This provides a few more additional characters for this species, viz., peduncle 1-flowered and lip entire with wavy margin besides peduncle 6-12-flowered and lip 2-lobed as described by earlier authors.

Excitation of Lunar Luminescence by Solar Flares

One of the theories of the origin of lunar craters is that they have been formed by the impact of meteors on the moon's surface. If that be so then the surface of the moon, especially near the craters, should be abundantly covered with meteoritic materials. When such surfaces are struck by "Solar wind" (which chiefly consists of protons) caused by solar flares, one may expect luminescence of the meteoritic material under the action of the proton bombardment.

Results of laboratory experiments simulating the above were reported recently by Derham and Geake of the Manchester College of Science and Technology. A number of samples of meteoritic materials were excited by a proton beam of energy about 40 keV. While results in most samples were drab, Derham and Geake observed that in the special case of the class of meteorites known as estatite achondrites the action of proton irradiation was to produce a

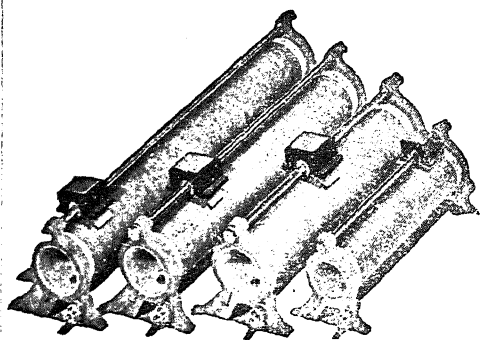
strong red luminescence with peak intensity at about 6700 Å.

As the lunar surface is bound to have received meteoritic material, including presumably some of the above class, it would be of interest to examine the luminescence of lunar craters and rays in the spectral region between 6500-6900 Å. Such a study of lunar photography through narrow-passband interference filters centred at  $\lambda$  6725 (red) and  $\lambda$  5450 (green) was undertaken in the Manchester University Department of Astronomy by Professor Kopal and his associate who have reported some significant observations illustrated by photographs of the moon (*Nature*, 1964, 201, 239).

During the night of November 1-2, 1963 in the almost simultaneous photographs of the Copernicus-Kepler region of the moon taken between 22.35 and 22.42 U.T. with the two filters, striking enhancement of surface brightness was shown in the red filter photograph of the Kepler area while there was no corresponding enhancement in the one taken with the green filter. On two additional pairs of plates taken between 23.00 and 23.08 U.T. the red enhancement had subsided almost completely, but again was distinctly shown on plates taken between 00.20 and 00.35 U.T. (November 2).

To explain these observed facts Kopal hypothesizes that the temporary enhancement of the Kepler area in the red, observed on the night of November 1-2, was caused by the luminescence of lunar ground covered by meteoritic debris, similar in composition to the samples which Derham and Geake induced to luminescence under proton bombardment simulating the solar wind.

Evidences from magnetic disturbances and variations in neutron counts on the earth on the days of observation, November 1-2, give room to suspect that some solar "events" took place on those days. If the above explanation is correct this will be the first case on record when the luminescence of lunar ground can be related with specific solar events; and, incidentally, would constitute a proof of the fact that the crater Kepler was produced by impact of a stony meteorite.—(*Nature*, 1964, 201, 239.)



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Echiumine (II) and Lasiocarpine (IV), and (iii) Cyclic diesters from a necine and a dicarboxylic acid, e.g., Dicrotaline (V) and Retrorsine (VI).

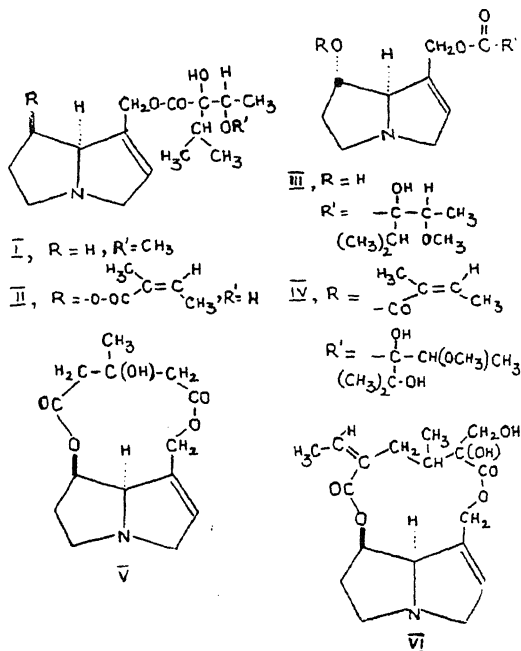


CHART 1

**Necines.**—The basic structures of the necines are 1-hydroxymethyl-1:2-dehydropyrrolizidine (VII a) and its 7-hydroxy derivative (VII b). By modifications all the necines numbering about eleven are derived. Some of them do not have the double bond.

Of these, the structures of seven of them are known with certainty. An individual necine may constitute the basic moiety of several different alkaloids and thus a small number of them produce a large number of *Senecio* bases. For example, retronecine, the necine from retrorsine, constitutes the basic moiety of 30 known *Senecio* bases. The striking feature of these necines is the interesting catalytic reduction which they undergo to yield the corresponding saturated methyl pyrrolizidines. This reaction was first observed in 1935 in the case of retronecine.<sup>12</sup> Subsequently this reduction has been applied to other necines. Though *Senecio* alkaloids are all esters, there are a few cases of necines occurring free. Laburnine [1-β-hydroxymethyl-(8β)-pyrrolizidine] (VIII) occurs free in the seeds of *Cytisus laburnum*<sup>13</sup> along with lupin alkaloids, which have different chemical characteristics. Obviously, there is no necic

acid in this plant source to effect the needed esterification. Incidentally, laburnine represents the simplest form of the necines. Surprisingly, this does not function as a necine in any of the known *Senecio* alkaloids but its optical antipode, trachelanthamidine (IX) is a true necine. Among other necines occurring free may be mentioned trifoliastrine (VII c) and trifoline (VII d) from *Crotalaria trifolium* and gorensine (VII e) from *C. gorensis*.<sup>14</sup>

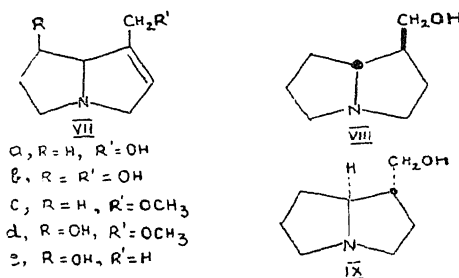


CHART 2

**Necic acids.**—As mentioned earlier the necic acids are obtained by alkaline or acid hydrolysis of these alkaloids. Some of them are monocarboxylic and some are dicarboxylic acids. Among thirty acids known so far, *senecioic* and *scleratinic* acids are the only two occurring free in plants.<sup>15-16</sup> Some of these necic acids are known to undergo structural changes during the degradation of these alkaloids. Hence the acids isolated from the hydrolysis reactions may not always be the same as originally present. For example, angelic acid, (*trans*-α, β-dimethylacrylic acid) (X), which is found in as many as eight *Senecio* bases bound in ester form, isomerises on heating or on treatment with sulphuric acid or with sodium hydroxide to yield tiglic acid (*cis*-α, β-dimethylacrylic acid) (XI). Therefore it is necessary to select the degradation conditions for these alkaloids so as to isolate the necic acids without affecting their structure. Angelic acid (C<sub>5</sub>-acid) (X) seems to be common for all the alkaloids belonging to the group of non-cyclic diesters. In the case of the cyclic diesters, the necic acids are usually substituted glutaric or adipic acid.

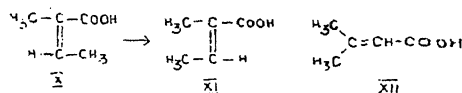


CHART 3

*Senecioic* acid (β, β-dimethylacrylic acid) (XII) has attracted considerable attention

connection with the biogenesis of the  $C_5$ -(isoprene) unit in plants. This acid has been considered to be the precursor of the isoprene unit which polymerises to rubber in plants<sup>17</sup> and to cholesterol in animal tissues.<sup>18</sup> Robinson suggested this as the basic precursor of all structures based on isoprene including the  $C_5$ -aromatic types.<sup>19</sup> Experiments on the biotransformation of senecioic acid into isoprenoid compounds have been described.<sup>20,21</sup> The observation that the acid occurs free in the rhizomes of *Senecio kœmpferi* (*Ligularia tussilaginea*)<sup>15</sup> supports Robinson's suggestion. However, doubts have been cast as to the general validity of this hypothesis, by the observation that the acid may undergo degradation to acetic acid before incorporation.<sup>22</sup> Mevalonic acid has now come to occupy the central place as the unit for producing isopentane derivatives. In the *Senecio* species it is interesting that senecioic acid occurs free. The other necic acids seem to have the isopentane skeletons found in this acid and indications are that they are related to this acid in biogenesis.

**Synthesis.**—Several of these necines and necic acids have been synthesised; the mono-ester alkaloids heliotrine and supinine have been reconstructed from their hydrolysis products. However, the total synthesis of not even a single cyclic diester alkaloid has been accomplished so far. By small changes inter-conversion of one alkaloid into another is known. For example, oxidation of tertiary amine bases to N-oxides and reduction of N-oxides to their corresponding tertiary amines.

**Biological activity.**—It has been shown as early as 1911 by Cushny<sup>23</sup> that these *Senecio* bases were effective agents in producing liver diseases in experimental animals. This specific activity distinguishes them from other groups of alkaloids, though they vary in degree of toxicity and in details of pharmacological action. However, some of these bases, e.g., platyphylline (XIII) and trachelanthamine (XIV) possess weak atropine-like activity and also produce local anaesthesia.<sup>24,25</sup> Some derivatives of the necine, trachelanthamidine have been synthesised and found to possess useful pharmacological properties.<sup>27,28</sup> The *p*-aminobenzoyl derivative (XV a) is as effective as cocaine in producing local anaesthesia, and the quinolylamine derivative (XV b) has anti-malarial activity. Pronounced spasmolytic properties have been attributed to the alkaloid hastacine,<sup>26</sup> the constitution of which has not yet been established,

Regarding the relationship between structure and biological activity of these alkaloids, the

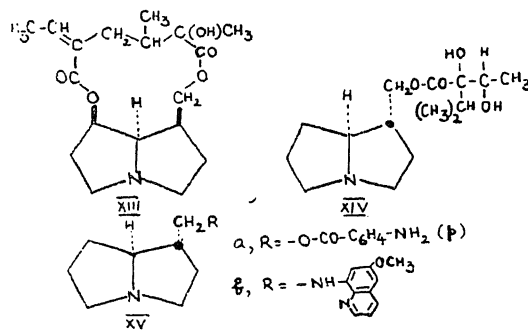


CHART 4

intact ester structure seems to be essential for producing liver diseases<sup>29,30</sup> and this is supported by the fact that neither the free necines nor the necic acids nor a mixture of both exert any such activity. Even the partial hydrogenolysis of the alkaloid fulvine (XVII) leads to an inactive product (XVIII).<sup>31</sup> Platyphylline (XIII), which differs from senecionine (XVI) by the absence of a double bond in the pyrrolizidine nucleus possesses no activity and hence the presence of the double bond is also indispensable for the activity. Diesters such as lasiocarpine (IV) are more effective than the monoesters like heliotrine (III). Compounds belonging to the cyclic diester group having 10 carbon atoms in the cycle are also effective agents. Branching of the carbon chain in the necic acid part has been proved to be essential for the activity. But the presence of an additional hydroxyl group or a double bond, a *cis* or a *trans* configuration at the ethylenic carbon atom and even difference in the stereochemical configuration of the pyrrolizidine nucleus have no effect on their biological properties.

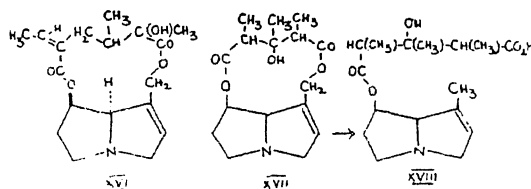


CHART 5

**N-Oxides.**—The interesting feature of the *Senecio* alkaloids is that several of them, e.g.,

heleurine (I), lasiocarpine (IV), retrorsine (VI), trachelanthamine (XIV), etc., are accompanied by their respective oxidation products, the N-oxides. The occurrence of N-oxides in nature is not uncommon. They are formed by easy oxidation of the corresponding tertiary amine and the oxygen atom is bound to the nitrogen by a co-ordinate link, as a result of which these N-oxides show large dipole moments in benzene solution. They are much weaker bases than the corresponding amines. The simplest of this class of compounds is trimethylamine-N-oxide and it is found to occur in the milk of cows fed on sugar-beet residues and also in marine fishes.<sup>32</sup> Recently, N-oxides are also known as microbial products. For example, the N-oxides of various alkyl derivatives of 4-hydroxyquinoline are present in the excretion of *Pseudomonas pyocyanea*.<sup>33</sup> Several of them have been obtained from plant sources also. The first alkaloid N-oxide to be isolated and studied was that of eserine from the seeds of *Physostigma venenosum* by Polonovski and Nitzberg.<sup>34</sup> Subsequently many others have been found to occur in plants, as for example the oxide of epilupinine, a quinolizine derivative from the seeds of *Lupinus varius*<sup>35</sup> and also that of N,N-dimethyl tryptamine and its 5-hydroxy derivative from *Piptadenia peregrina*.<sup>36</sup>

Among the alkaloid N-oxides reported so far, a large number belong to the pyrrolizidine series. Because of the tertiary nature of the nitrogen and strongly basic character, these bases seem to form N-oxides readily. About twelve of them have been isolated from different species of *Senecio*, *Heliotropium* and *Trachelanthus*. The first such compound to be isolated and identified was trachelanthine (trachelanthamine-N-oxide) (XIX) from *Trachelanthus*

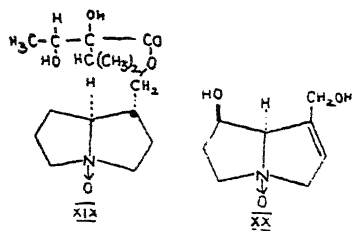


CHART 6

korolkovi.<sup>37</sup> Recently, the N-oxide of retrorsine (XX) has been found to occur in *Crotalaria retusa* along with other alkaloids, retusamine and mitchelliine.<sup>14-38</sup>

The N-oxides are detected by various methods as follows: (i) They produce red colour with acetic anhydride;<sup>39</sup> (ii) silicotungstic reagent reacts with alkaloids and their N-oxides, whereas Mayer test is given only by the alkaloids<sup>40</sup> and (iii) the  $R_f$  values of these N-oxides in paper chromatography are almost unchanged, when butanol-ammonia is used in the place of butanol-acetic acid, whereas the corresponding tertiary amines have much higher values in the basic solvent system.<sup>41</sup>

Different methods have been employed by different workers in effecting the separation of these N-oxides from the corresponding amines: they involve different sequences of extraction with organic solvents and extraction at increasing pH levels. Sometimes, taking advantage of their easy reduction they are reduced to the corresponding tertiary amines and the total alkaloids are obtained. Incidentally, this method has been used to estimate the quantity of N-oxide present in plants. Chromatography is being used widely in the separation of both alkaloidal amines and amine oxides.<sup>42</sup>

N-Oxides can be easily prepared by oxidising the tertiary amines with hydrogen peroxide.<sup>37-43</sup> They are also equally effective in inducing liver lesions. The content of amine and amine oxides in *Senecio platyphyllus* at various stages of growth has been investigated in detail by Areshkina,<sup>44</sup> who reported that the amount of N-oxides reaches a maximum just before flowering and then it goes down and becomes the minor constituent, the corresponding amine being predominant in the seed. These oxides are reduced by ascorbic acid although fructose, glucose and glycine have no effect.<sup>45-46</sup> They form a convenient oxidation-reduction system and may play an important role in the metabolism of plants.

**Chlorine compounds.**—Chlorine-containing organic compounds are not many in the plant kingdom.<sup>47</sup> The earliest to be discovered was the depsidone, diploicin from the lichen, *Buellia canescens*. The well-known antibiotic, chloramphenicol, is another example and was considered at that time to be extraordinary. Now many more are being discovered, particularly in the group of polyphenols. Such examples are known in the pyrrolizidine group of alkaloids also. The alkaloid Jacoline, isolated by Manske,<sup>48</sup> from *Senecio jacobaea*, has been recently shown to contain chlorine by Bradbury and Culvenor<sup>49</sup> and the revised molecular formula is  $C_{20}H_{32}ClNO_7$ . Mitchelline

$C_{14}H_{20}ClNO_6$ , isolated from *Crotalaria mitchellii* is another example.

**Conclusion.**—As mentioned earlier, the importance of the study of cattle poisons and herbal medicines is vast for a country like India, where life is based largely on agriculture and animal husbandry and where plants of large variety abound. Adequate interest in this line of study has not so far been taken in this country and there is no doubt a study of this problem will be of vital consequence for the health and safety of the nation.

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## ON THE OCCURRENCE OF 'RED WATER' PHENOMENON ON THE WEST COAST OF INDIA\*

A. PRAKASH

Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

AND

A. H. VISWANATHA SARMA

Indian National Committee on Oceanic Research, C.S.I.R., New Delhi

**T**HE phenomenon of discoloured sea-water, which owes its origin mainly to a very high and localized concentration of marine phytoplankton, has been observed in various parts of the world. Such discolourations may be of any shade between red, brown, yellow and green, depending upon the causative organism involved. Although the term 'red tide' has often been used rather indiscriminately to describe discolourations which are not necessarily red and may not be of biological origin, the characteristic red water is caused primarily by the dinoflagellates. Various genera like *Cochlodinium*, *Gonyaulax*, *Gymnodinium*, *Noctiluca* and *Peridinium* have been implicated.

The study of red water phenomenon is of considerable interest not only from the biological standpoint, but also due to economic reasons since mass mortalities of commercially important fish and shellfish have been caused by red water outbreaks in diverse geographic locations. On the west coast of India, discoloured water caused by a variety of organisms and sometimes associated with mass mortality of local marine fauna, has been reported from several localities (refer Hayes and Austin, 1951; Brongersma-Sanders, 1957 and Subrahmanyam, 1959 for bibliography). The dinoflagellates associated with red discolourations in the coastal waters have been identified as *Noctiluca miliaris* (Bhimachar and George, 1950); *Gymnodinium* sp. (Subrahmanyam, 1959); two species of *Cochlodinium* (Hornell and Nayudu, 1923); and an unidentified Peridininian (Hornell, 1917). Recently, while participating in the International Indian Ocean Expedition Programme, an interesting phenomenon of red water caused by a different dinoflagellate species was observed on the west coast of India. Details are given below:

On November 5, 1963, while on a collection trip on board the Indo-Norwegian Project vessel 'KALAVA', an extensive patch of red water was sighted about eight miles north-west of

Cochin Harbour. Being a bright sunny day with an extremely calm sea, it was possible to see rust-red or brick-red water for miles around. At our request the Commander, Naval Air Station at Cochin, arranged to send a few reconnaissance flights over the red water area that evening and also on subsequent days. The purpose of these flights was to get an idea of the exact locations, configurations, and the spread of discoloured water patches. The Pilots reported sighting a few red water patches along the coast, the largest patch being about 10 miles wide and drifting in a north-westerly direction away from the coast.

Microscopic examination of the red water samples collected that day revealed that the discolouration was caused by an extensive bloom of *Gonyaulax polygramma* Stein—a common tropical and sub-tropical dinoflagellate, hitherto not recorded from the west coast of India. *G. polygramma* was present in very high concentrations and cell counts of the bloom samples using Utermohl's method gave the density as high as 11,000,000 cells per litre of sea-water. This species presented an almost monospecific natural culture comprising about 99% of the total number of organisms present in the bloom samples. Other phytoplankton species were very insignificant in numbers and there was a virtual exclusion of zooplankters (Table I).

Except for *G. polygramma* all the other species listed in Table I have already been recorded from the west coast of India (Subrahmanyam, 1958). Only two species of *Gonyaulax*, viz., *G. diegensis* and *G. scrippsae* have been included in Subrahmanyam's list of the phytoplankton organisms of the west coast of India and none of these have been known to occur in such high concentrations as to cause red water.

*G. polygramma* is essentially a warm water species and has been reported from many areas in the tropics and sub-tropics. It is of common occurrence in the Indian Ocean and has been recorded from the Gulf of Aden, Arabian Sea,

\* Contribution from the Indian Ocean Biological Centre, Ernakulam, India.

TABLE I  
Composition of the red water

Component organisms	Cell count/litre	Percentage
<b>DINOFLAGELLATES</b>		
<i>Gonyaulax polygramma</i> ..	10,828,000	99.00
<i>Peridinium steinii</i> ..	9,000	0.08
<i>Irorocentrum micans</i> ..	8,000	0.07
<i>Ornithocercus magnificus</i> ..	7,000	0.06
<i>Peridinium crassipes</i> ..	7,000	0.06
<i>Peridinium granii</i> ..	4,000	0.04
<i>Peridinium pentagonum</i> ..	3,000	0.03
<i>Peridinium d. pressum</i> ..	2,000	0.02
<b>DIATOMS</b>		
<i>Noctinoema costatum</i> ..	63,000	0.57
<i>Rhizosolenia styliformis</i> ..	2,000	0.02
<i>Navicula</i> sp. ..	2,000	0.02
<i>Cocconeis nystrix</i> ..	1,000	0.01
<i>Nitzschia seriata</i> ..	1,000	0.01
<b>MICROFLAGELLATES - unidentified</b>		
	?	?

eastern and southern coasts of Africa, off the Maldives and Australia (Wood, 1963). Therefore, the occurrence of this species on the west coast of India is by no means unique, nevertheless, its presence in the form of vast monospecific bloom in the coastal waters is certainly of interest because of the reported ill-effects of its blooms on marine life. Nishikawa (1901) reported that 'red tide' caused by *G. polygramma* bloom in the Bay of Agri in Japan was responsible for considerable destruction of oysters and was generally toxic to other organisms. Mass mortality of fish and marine invertebrates near Cape Town, South Africa, has been attributed to red water bloom of *G. polygramma* by Grindley and Taylor (1962). It is not clear from Nishikawa's account if the mass destruction of marine life in Japan was due to actual release of the toxic principle by the dinoflagellates into the surrounding water. In the case of South African mortality, however, Grindley and Taylor are of the opinion that the death of fish and invertebrates was due to lack of oxygen in the water which had resulted from mass decay of the red plankton and was aggravated by the release of decay products.

Since a number of *Gonyaulax* species, viz., *G. tamarensis*, *G. catenella* and *G. polyedra* are capable of producing extremely potent toxins lethal to various animal groups as well as to human beings, it was decided to test the toxicity, if any, in the case of *G. polygramma*. Attempts to raise *G. polygramma* in axenic unialgal cultures in the laboratory had to be abandoned due to lack of proper facilities, but it was possible to prepare 'acid extract' of the cells concentrated from fresh red water samples for bioassay. Procedures for the preparation of

extract and for bioassay were similar to those adopted for *G. tamarensis* by Prakash (1963). A series of toxicity tests were conducted on white mice at the Haffkine Institute, Bombay, and in each case the characteristic neurotoxic symptoms leading to death of the mice were missing. Based on these observations, we are of the opinion that *G. polygramma* bloom off Cochin was non-toxic. No fish or other mortality as a result of red water bloom was observed or reported from the surrounding areas. However, there was some evidence from the fishing log of R.V. 'KALAVA' that fish seemed to avoid the bloom area but appeared again in the same area after two days when the bloom had drifted away.

Based on the positions of the various red water patches given by Naval aircrafts, we have attempted to determine the average rates of surface drift in the coastal water off Cochin for the two consecutive days. The general direction of wind during the bloom period was westerly (270°) and that of the red water drift was north-westerly (325°). Table II summarises the main meteorological conditions at the time of red water bloom and the calculated rates of surface drift.

TABLE II  
Meteorological conditions at Cochin during red water bloom

Date	Air Temp. °C. (Surface)		Sky	Wind speed (knots)		Calculated drift rate (miles/hr.)
	Max.	Min.		Max.	Mean	
November 4	31.8	24.5	clear	14	7	..
November 5	32.0	23.7	clear	11*	9	0.67
November 6	31.6	22.7	clear	7*	variable	0.53

\* Reported calm after 6 p.m.

Since red water blooms are largely a surface phenomenon and winds and currents are primary factors governing their distribution, the use of aircrafts in locating and regularly following such discoloured water patches over a certain time period suggests an interesting possibility of estimating the rate and direction of the surface water drift. Of course, for a more refined estimation the growth potential or the generation time of the causative species must be taken into account.

The exact mechanism of the development of a monospecific dinoflagellate bloom causing red water is not fully understood. Primary factors

like light, temperature and nutrients which control the production of phytoplankton in the sea are not the only necessary conditions for the establishment and subsequent development of a monospecific bloom. Probably certain other factors or a combination of factors is involved. The period of maximum phytoplankton production on the west coast of India is during the south-west monsoon months, May-September, with production peak occurring in July or August (Subrahmanyam, 1959). But most red water blooms on the west coast of India have been observed during September-November, and according to Bhimachar and George (1950) there appears to be a periodicity in the occurrence of such blooms. The obvious explanation for this periodicity appears to be the onset of north-east monsoon. There is also a suggestion that during this period water of lower salinity from the Bay of Bengal enters the coastal circulation on the west coast of India and probably favours development of blooms of certain species (Subrahmanyam, 1960). While certain dinoflagellate species are known to require a discrete mass of water of relatively low salinity for their growth, it does not imply that salinity difference is the sole requirement for the development of a monospecific bloom. Laboratory studies on dinoflagellate cultures have provided some clues to what makes the water physiologically suitable for growth, but this is still a very open question and more work is needed in this field. Hydrographic information from the west coast of India, particularly that concerning the origin and characteristics of the coastal water masses, is at present too sketchy to put forward a

reasonable hypothesis. A study of the physiological ecology of the causative organism in relation to physical and chemical characteristics of the coastal waters would be a right step towards understanding the phenomenon of blooms causing red water.

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## EFFECTS OF TEMPERATURE ON THE SWELLING OF COMPRESSED CLAYS

B. K. KAUL

Department of Civil Engineering, Indian Institute of Technology, New Delhi-16

COMPRESSED CLAYS exhibit appreciable swelling when the pressures under which they have been compressed are decreased. The swelling does not follow the exact theoretical relationships which would be predicted with the aid of the Guoy-Chapman theory (Bolt, 1956; Olsen, 1956). The swelling is influenced by the extent of the diffused double-layer formation around the clay particles and the physico-chemical characteristics of the fluid present within the pores of a clay sample (Barshad,

1949; McEwan 1948; Grim, 1962; Kaul, 1963). Temperature variations alter the extent of the diffused double-layer formation, the physico-chemical constants of the fluid (dipole moment, dielectric constant, and viscosity) and the structural configuration of the water molecules in the adsorbed layers around the clay particles.

Three types of clay minerals: kaolinite, illite and montmorillonite, which represent the three major groups into which clay minerals are divided, have been used for study. X-ray



identification indicated a high degree of purity (Kaul, 1963). These clays were fractionated and only particles finer than two microns in size were used. They were converted into Na-saturated forms and the concentration of salts within the pore water was reduced to 0.01N NaCl by repeated washings with distilled water.

The samples were compressed in brass rings allowing drainage of pore water from the top and bottom of the samples through porous stones. The loads were increased in steps using a consolidation frame, to a maximum pressure of 64,000 lb./s.ft. The samples were kept saturated during this process by immersing in a small container containing water having the same concentration of salts as the pore water in the samples. The temperature of this container

could be maintained at the desired value. The samples were allowed to swell by reducing the pressure in one step to 16,000 lb./s.ft. and allowing the samples to swell as much as possible. When the swelling under this pressure was completed the samples were unloaded to 4,000 lb./s.ft. and again allowed to swell. The swelling measurements were recorded with the aid of a dial gauge to an accuracy of 0.00015". In Figs. 1 to 3 the swelling is plotted in terms of "Swelling index" (which is the ratio of the increase in the thickness of the sample,  $\Delta H$ , to the height of the solids,  $H_s$ , within the sample) against the logarithm of time.

The swelling time plot can be divided into three stages as under :

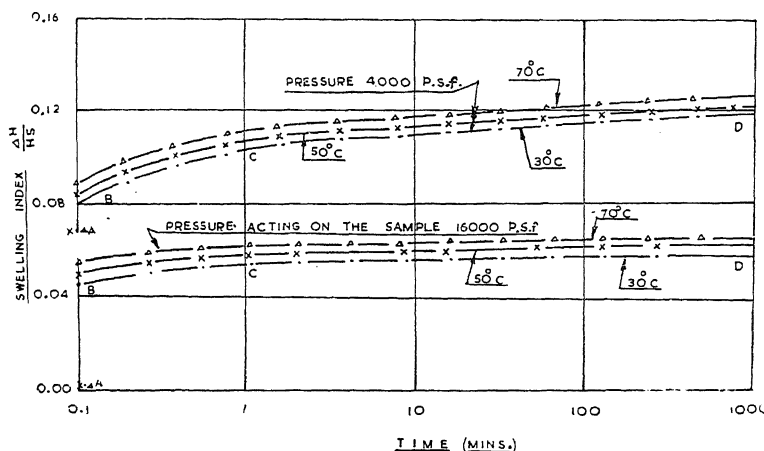


FIG. 1. Swelling Curves of Na-Kaolinite

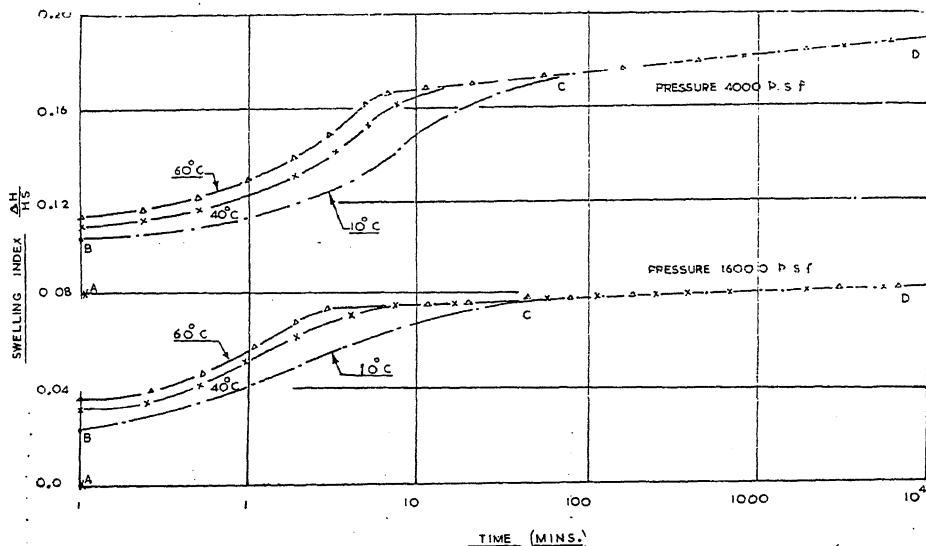


FIG. 2. Swelling Curves of Na-Illite

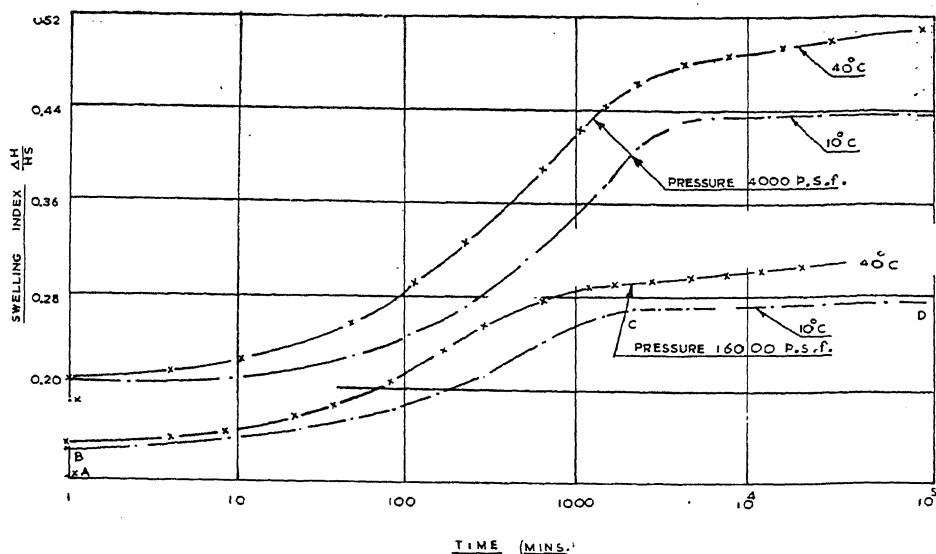


FIG. 3. Swelling Curves of Na-Montmorillonite

I. The initial sudden expansion which takes place in less than 1/10th of a minute. This seems to be mainly a result of the rebounding of the clay particles when the pressures are released and could be a sort of 'elastic recovery' (portion AB in Figs. 1 to 3).

II. The swelling due to the electro-chemical forces of the diffused double-layer formation around the clay particles (portion BC in Figs. 1 to 3).

III. A gradual adjustment between the particles which takes place at a decreasing rate (portion CD).

A major portion of swelling exhibited by kaolinite is completed within stage I. The kaolinite has particles of larger dimensions than the other two types of clays. During com-

pression these get bent to a greater extent. The particles of illite and montmorillonite have smaller dimensions and elastic recovery is thus felt to a greater extent. At higher temperatures this recovery is less pronounced.

The swelling during stage II, due to the repulsive forces of electric double layer formation around the particles, is of greater magnitude for montmorillonite clay than for illite and for kaolinite. The temperature effect is of the same order. For illite the total swelling is about the same for all of the testing temperatures, whereas the rate of swelling during stage II is increased with an increase in the temperature. In the case of montmorillonite the rate of swelling as well as the magnitude of swelling is increased with an increase in temperature (Table I).

TABLE I  
Influence of temperature on the three stages of swelling (pressure acting on the samples is 16,000 lb./s.ft.)

Clay type		Temperature (° C.)	Swelling			St	
			Stage I	Stage II			Time needed for the completion of this stage (minutes)
			(Change in swelling index)	(Change in swelling index)	(Ch swel per l tim		
Kaolinite	..	30	·040	·008	1		
		50	·044	·008	1		
		70	·048	·008	1		
Illite	..	10	·020	·056	50		
		40	·028	·048	7		
		60	·032	·044	2		
Montmorillonite	..	10	·016	·128	2000		
		40	·020	·194	1200		

An increase in temperature causes an increase in the repulsive forces between the clay particles as calculated from the Guoy-Chapman theory. The structural regularity of the adsorbed water molecules around the clay particles decreases with an increase in temperature causing a greater freedom of movement (Martin, 1962; Kaul, 1963). Montmorillonite, due to high base exchange capacity and a high specific surface area, has a greater development of diffused double layers and adsorbed water layers around its particles. Consequently, the temperature effects are felt to a greater degree in this type of clay.

In the final stage of swelling, the rate of swelling (when plotted on a logarithmic time scale) is a straight line. This rate decreases with time but the process of adjustment continues for a considerable time. The slope of this line is not affected by temperature variations in the case of kaolinite and illite. Steeper slopes are observed for higher temperatures in the case of montmorillonite. During this stage there is a continuous adjustment between the particles into a stable configuration. The adsorbed water layers around the clay particles hinder this adjustment. With increase in tempe-

perature the structural regularity of the adsorbed water decreases and thus adjustments at a greater rate are possible.

The effect of temperature on swelling is thus considerable in the case of montmorillonite clay mainly because of an increase in the repulsive forces between the particles and a decrease in the structural regularity of the adsorbed water layers around the particles with an increase in temperature. In the other two types of clays studied the effects of these two factors are not felt to a considerable degree due to their having low base-exchange capacity and lower specific surface area.

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Bangalore-6,  
February 28, 1964.

(Sd.) S. R. S. SASTRY,  
Publisher, Current Science..

## LETTERS TO THE EDITOR

CHEMICAL COMPONENTS OF  
*ALECTRA PARASITICA*

*Alectra parasitica* var. *chitrakutensis* is a parasitic plant, belonging to the family of Scrophulariaceae and it grows on the roots of *Viter negundo*. It is 8-9" in height and bears small yellow flowers. Its rhizome is turmeric yellow in colour, which becomes dark brown on drying. It is found all round the year at Chitrakut, Banda District of Uttar Pradesh.

This plant has been used in the Ayurvedic system of medicine for over a long period for the treatment of various skin diseases, especially leprosy. However, it has been botanically identified and named only recently. Recent clinical trials have shown that the mature rhizomes in the form of dried powder are useful for treatment.<sup>1</sup> Since the chemical study of this plant has not been carried out earlier, it has now been taken up using both the flowering stems and the rhizomes that were collected from Chitrakut (Uttar Pradesh).\*

The flowering stem collected in April 1963 and air-dried (50 g.) was extracted with hot ethanol and the extract concentrated to a small volume when a colourless crystalline solid separated. It was filtered and when crystallised from methanol, it separated as colourless fine needles, m.p. 163-65°. It is readily soluble in water, less soluble in alcohol and insoluble in ether. Its melting-point, elemental analysis and properties agreed with those of mannitol. The identity was confirmed by mixed melting-point and the preparation of its acetate, m.p. 124-25°, agreeing with that of mannitol hexaacetate. The alcoholic filtrate on concentration yielded a thick syrup, which was dissolved in minimum quantity of ethanol and cooled in ice. Some more quantity of mannitol was obtained. Total yield 1.5% of the air-dried stem.

The dried rhizomes (100 g.) were powdered and extracted successively with petroleum ether (60-80°), chloroform and then with ethanol. The petroleum ether extract yielded an oily residue, which answered the colour reactions characteristic of carotenoids. As the quantity was small, it was not investigated further.

The chloroform extract gave a red crystalline substance. It was insoluble in water and most of it dissolved in aqueous sodium carbonate and sodium hydroxide. It was stirred with aqueous

sodium carbonate (5%), filtered and the filtrate acidified with dilute acetic acid. The precipitated orange-yellow solid was filtered and on crystallisation from benzene, it separated as orange-yellow needles, m.p. 210-12°. Yield 2.0%. The pigment was sparingly soluble in ether and fairly soluble in ethanol, benzene and chloroform. It gave a red colour with alcoholic ferric chloride. It dissolved in concentrated sulphuric acid with an intense blue colour and on boiling a solution of it in acetic acid with concentrated hydrochloric acid, a violet colour was produced. Antimony trichloride in chloroform solution produced a green colour which changed to blue. All these colour reactions indicated that the pigment was carotenoid in nature and was an acid. The melting-point, properties and analytical data suggested that it may be azafrin, which was isolated earlier from the roots of *Escobedia scabrifolia* and *E. linearis*.<sup>2</sup> It had absorption maxima at 428 and 458 m $\mu$ , which are characteristic of azafrin. Its infra-red spectrum in KBr showed bands at 3571 cm.<sup>-1</sup> (OH), 1675 cm.<sup>-1</sup> (C=O of  $\alpha$ ,  $\beta$ -unsaturated acid), 1538, 1582 and 1613 cm.<sup>-1</sup> (conjugated double bonds) and 975 cm.<sup>-1</sup> (trans C=C). Final confirmation was obtained by direct comparison of the pigment with an authentic sample of azafrin, kindly supplied by Prof. R. Kuhn of Max-Planck Institute, Heidelberg and the mixed melting point was undepressed. This sample also gave appreciable red colour with alcoholic ferric chloride. The methyl ester, prepared by using methyl iodide, acetone and potassium carbonate, melted at 191-93°, which agreed fully with that of azafrin methyl ester.

The carbonate insoluble fraction was small in quantity and on chromatography over neutral alumina using chloroform separated into three fractions and each of them gave the colour reactions for carotenoids. As the yield was very poor, further work on these fractions could not be done.

The ethanolic extract of the rhizomes was concentrated and allowed to stand at room temperature overnight. The separated solid on crystallisation from methanol yielded colourless needles, m.p. 165-66°, which were found to be identical with mannitol isolated from the flowering stem. The filtrate was treated with excess

ether, when a thick syrup was precipitated from which more of mannitol was obtained as described earlier. Yield 1.5%.

It therefore appears that azafrin and mannitol constitute the major components of the parasitic plant, *Alectra parasitica*. Whether they are responsible for the curative properties of the plant is under investigation.

Our thanks are due to Prof. R. Kuhn for an authentic sample of azafrin.

Dept. of Chemistry, T. R. RAJAGOPALAN.  
Delhi University, T. R. SESHADRI.  
Delhi-6, February 20, 1964.

\* Kindly supplied by Dr. C. Dwarakanath, Adviser in Indigenous System of Medicine, Ministry of Health, Government of India, New Delhi.

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## CHEMICAL COMPONENTS OF THE STEM BARK OF CASSIA FISTULA

EXTRACTION of the powdered stem bark of *Cassia fistula*<sup>1</sup> first with petroleum ether removed most of the waxes and resins and yielded no crystalline products. Subsequent extraction with acetone or ethyl acetate gave only one crystalline component, optically inactive, m.p. 245-247° (d.) after several crystallisations from ethyl acetate-petroleum ether (ten times). Its molecular formula worked out to  $C_{15}H_{14}O_6$ , and it gave the following colour reaction: a greenish-blue ferric colour in alcoholic solutions; a red colour which deepened on warming with alcoholic hydrochloric acid and a cherry red colour with vanillin and hydrochloric acid. On acetylation using acetic anhydride and pyridine, it gave a pentaacetate, m.p. 172-73°, a trimethyl ether, m.p. 158-59° and a trimethyl diacetate, m.p. 132-34°. Oxidation of the trimethyl ether with potassium permanganate gave anisic acid and 2-hydroxy-3, 4-dimethoxy-benzoic acid as its methyl ester, m.p. 75-76°, confirmed by a mixed melting point determination with a synthetic sample of methyl-2-hydroxy-3, 4-dimethoxy benzoate. These experimental results establish its constitution as racemic or meso-3, 4, 7, 8, 4'-pentahydroxyflavan. A comparison of the properties of this component with terracacidin isolated by Clark-Lewis *et al.*<sup>2</sup> possibly show that both are identical except for their difference in optical activity. This has prompted us to designate this new component

as "Fistucacidin", obtained pure and in a crystalline state compared to terracacidin. Fuller details would be published elsewhere.

One of the authors (T. V. P.) conveys his thanks to the C.S.I.R., for the award of a research fellowship.

Dept. of Chemistry, V. VENKATESWARLU.  
Andhra University, T. V. PADMANABHA RAO.  
Waltair, January 30, 1964.

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## RESACETOPHENONE-OXIME AS A REAGENT FOR DETECTION OF COBALT AND SEPARATION OF COBALT FROM NICKEL

RESACETOPHENONE-OXIME has been suggested for the detection and determination of copper,<sup>1-2</sup> iron (III)<sup>3</sup> and nickel.<sup>4</sup> It was thought necessary to investigate further application of the reagent for the detection of cobalt.

Resacetophenone-oxime is prepared by refluxing resacetophenone in alcoholic solution with hydroxylamine hydrochloride. The oxime was recrystallised from ethyl alcohol, m.p. 198° C. A 0.2% solution was prepared by dissolving 0.2 gm. of oxime in 10 ml. of alcohol and diluting to 100 ml. with distilled water. The solution was stored in amber-coloured bottle.

*Detection of cobalt.*—It was observed that cobalt does not react with the reagent in acidic medium but gives yellowish-brown colour in ammoniacal medium (pH 7-11). If the concentration of cobalt is very low, pale yellow colour is obtained. The addition of dilute solution of sodium hydroxide also gives similar result with cobalt and reagent. The results obtained in ammonia and ammonium acetate medium are far more satisfactory. The colour is stable even if excess of ammonia or sodium hydroxide is added but fades on addition of concentrated mineral acid.

*Recommended procedure for Spot Test.*—A drop of test solution is placed on the spot plate, followed by 1-2 drops of 10% ammonium acetate, 1 drop of dilute ammonia (4-6 N) and 2 drops of reagent. (The addition of ammonium acetate prevents the precipitation of cobalt hydroxide.) Yellowish-brown or yellow colour develops immediately depending on the concentration of cobalt.

Sensitivity : 1.2  $\mu$ g. of Co.

Concentration limit : 1 in 1,00,000.

**Separation of cobalt from nickel using the reagent.**—Nickel<sup>4</sup> gives greenish precipitate with the reagent in slightly acidic buffer medium whereas cobalt gives brown or yellow colour in alkaline medium. Hence cobalt can be separated from nickel with this reagent.

**Recommended procedure for separation and detection of cobalt in presence of nickel.**—The solution containing nickel and cobalt (in the form of chloride or sulphates) is treated with 5 ml. of 10% ammonium acetate followed by 1-2 drops of dilute ammonia (4-6 N) and excess of reagent (0.2%) until there is no more precipitation of nickel. The solution containing the precipitate is heated to boiling and filtered. The filtrate is made distinctly alkaline with few drops of ammonia (or NaOH). The appearance of brown or pale yellow colour indicates the presence of cobalt. Thus resacetophenone-oxime can be advantageously used to separate and detect cobalt in presence of nickel in qualitative analysis.

The author is thankful to Dr. S. Siddappa for his keen interest and encouragement in this work.

Dept. of Chemistry, S. G. KADARMANDALGI.  
Karnatak University,  
Dharwar-3, November 30, 1963.

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### EFFECT OF TESTOSTERONE PROPIONATE ON BONE GROWTH IN VITRO

In organ-culture experiments using chick-embryo-bone rudiments it has been shown that insulin,<sup>1</sup> cortisone,<sup>2</sup> and estrogen<sup>3</sup> have a marked effect on the growth rates of bones with demonstrable histological changes in the cartilage cells. The male hormone testosterone is capable of promoting growth in patients of pan hypopituitary dwarfism, by stimulating the tissues including epiphyseal cartilage.<sup>4</sup> Simpson *et al.*<sup>5</sup> have reported that testosterone accelerated growth induced by the pituitary growth-hormone in hypophysectomized rats. Studies by Rubinstein and Solomon<sup>6</sup> and of Kochakian and

Endahl<sup>7</sup> have shown that large doses of testosterone propionate to young rats depressed growth while in much smaller doses, the rats responded with increased body weight and length of bone. However, it is not possible to conclude from the *in vivo* experiments whether the action of testosterone is due to a direct effect on the growth of cartilage, an indirect action through its effect on some other hormones or due to general impact on metabolism of the whole body. The present report describes our experiments on the effect of testosterone on bone growth *in vitro* of embryonic chick-bone rudiments cultured according to the watch glass method of Fell and Mellanby<sup>8</sup> and it is shown that testosterone propionate has direct effect on the growth of bones.

The femur, tibia and humerus of 7 days old chick-embryos were dissected under a binocular microscope, one limb used as control was cultivated in a medium without testosterone propionate, while the other limb bones were treated with the test hormone. Testosterone propionate (Testoviron preparation of Schering) was added to the nutrient plasma, mixed well and used for cultivation. The bone rudiments in the experimental samples. Within 2 or 3 days the rudiments were transplanted in fresh clot. Growth measurements were done at the beginning, before every transplantation and at the end of the culture, by drawing the projected images of the bones on paper using an Edinger drawing apparatus. The total area was measured by means of a planimeter.

Three concentrations of testosterone propionate were studied and the results (mean of 12 different experiments) summarised in Fig. 1. It may be seen that at the higher concentrations 1.24 mg. or 0.125 mg./ml. testosterone exhibited a definite inhibiting effect on the growth as compared to controls. During the earlier stages of testosterone treatment, the highest concentration used 1.25 mg./ml. showed more inhibiting effect than the lower concentration 0.125 mg./ml. Thus at the time of the first transplantation 2 days after the beginning of the experiment, the untreated bones had an average area of 3.9 sq. cm. while those treated with 1.25 mg./ml. testosterone had only 3.65 sq. cm. and those treated with 0.125 mg./ml. had grown to 3.85 sq. cm.; however almost equal inhibition was apparent at both concentrations at the end of 7 days. Contrary to these above experiments, bones treated with 0.0125 mg. testosterone/ml. proved to be slightly stimulatory (Fig. 2). This is in

EFFECT OF TESTOSTERONE PROPIONATE ON THE GROWTH  
OF CHICK-LIMB-BONE RUDIMENTS IN CULTURE

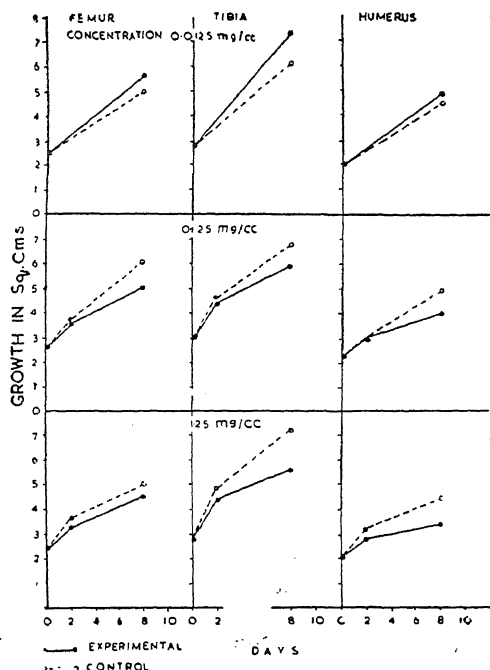


FIG. 1. Mean of the growth of the bones (12 expts.) in sq. cm. with different concentrations of testosterone propionate in the nutrient plasma, plotted against number of days of incubation.

agreement with the *in vivo* observations that testosterone injected in low concentrations (less than 25 micrograms per day) in young male rats stimulated body growth and bone length whereas large doses retarded growth.<sup>7</sup>

Histological examinations of the sections of bones stained with haematoxylin and eosin showed no marked changes between the controls and treated ones excepting that the testosterone-treated bones were less basophilic than the controls. Staining with toluidine blue for metachromasia showed that there was considerable loss of metachromatic staining material in the hormone-treated bones, compared to controls. It would appear from the results of the present study that the effect of testosterone on bone growth is direct, slightly stimulatory at very low concentrations but definitely inhibitory at high concentrations. Preliminary experiments consisting of treatment of lysosomal particles of normal rat liver with testosterone resulted in the release of the enzymes acid phosphatase and cathepsin indicating that the mechanism of action of

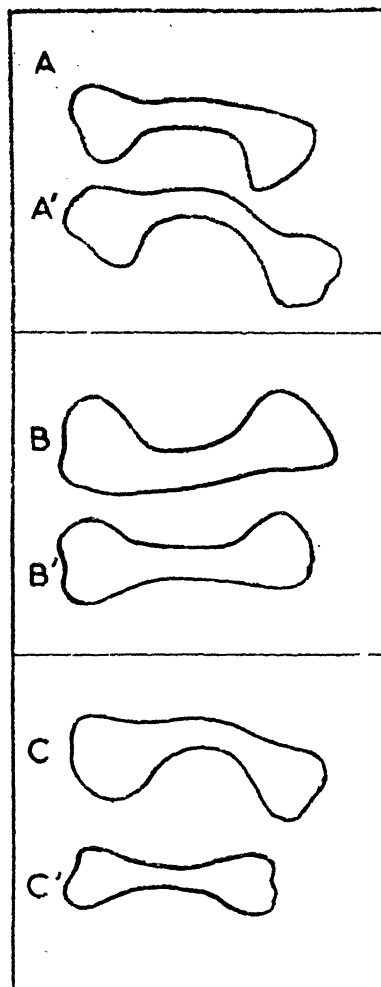


FIG. 2. Projected images of femur from chick embryos cultivated with and without testosterone propionate after 8 days in culture. Top to bottom, 0.0125 mg./ml., 0.125 mg./ml. and 1.25 mg./ml. of the hormone treated. A, B and C are controls and A', B' and C' are experimental samples.

testosterone on the bone cartilage was similar to that ascribed to excess vitamin A in similar experiments reported by Fell *et al.*<sup>9</sup>

Dept. of Pathology,  
Medical College,  
Trivandrum,  
Kerala State, November 16, 1963.

P. G. SARALAMMA.  
S. KRISHNAMURTHY.  
M. THANGAVELU.

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### A BATH OF SYNTHETIC "SAND" FOR MICRO-KJELDAHL DIGESTION

SOME Clinical Laboratories which handle a variety of Sera keep on to the micro-Kjeldahl procedure for estimation of serum proteins. The distillation itself is most convenient for dealing with a series but the preparation of protein digests over a gas flame is often a matter of annoyance because of the erratic behaviour of micro-burners fitted to conventional digestion racks. If a "sand"-bath could be contrived to contain instead of sand a material which would uniformly distribute the heat of a single bunsen burner and maintain at the same time a temperature at about the boiling point of sulphuric acid, we should expect digestion to proceed smoothly in tubes without the need for constant supervision.

For the past four years, a flat metal dish, 13.5 cm. in diameter containing about 150 g. of carborundum abrasive powder grit 80 to a depth of 1.5 cm. has been in continuous use as "sand"-bath for digesting twelve samples at a time with the aid of a Meker burner giving 30 mm. diameter flame or two standard sized bunsen burners. Of the metals tested, only stainless steel has proved suitable as container for the hot carborundum powder. Iron, copper and aluminium dishes get perforated within a few hours of heating.

Pyrex test-tubes, 6"  $\times$  3/4", are satisfactory for digestion. The tubes are inserted through holes in a plate held horizontally at a distance of 10 cm. from the plate. A short, thick glass rod with a bulbous end and bent in the shape of an L serves as a condenser when inserted into the tube.

The following procedure has been used for the estimation of serum proteins. Serum 0.5 ml. is pipetted into 9.5 ml. of 22.2% sodium sulphate solution kept in a conical centrifuge tube. Immediately after mixing the contents, 1.0 ml. is pipetted into 6"  $\times$  3/4" Pyrex tube for micro-Kjeldahl digestion. After allowing the rest of the solution in the centrifuge tube to stand for some time, 3 ml. of ether are added.

The tube is shaken for 30 seconds and centrifuged for 10 minutes at 3,000 r.p.m. With the upper end closed with the finger, a 1 ml. single mark pipette is inserted along the side to pierce the globulin cake and enter the albumin layer. The finger is released and 1 ml. of albumin solution transferred to a Pyrex tube for digestion.

Into each tube containing the albumin and globulin solutions are placed two glass beads, 0.5 ml. conc.  $H_2SO_4$  and one drop of 5% aqueous  $CuSO_4$  solution. After placing on the bath, the tubes are kept shaken for a minute or two. The preliminary shaking is necessary because there is the risk of undue frothing and spurting occurring within the first three minutes of digestion. The solution clears in 25 minutes but the digestion should be continued for 50 more minutes. The tube is removed and kept for 5 minutes to cool. The condenser is withdrawn after washing with 5 c.c. of water and the tube shaken to dissolve the digest which tends to cake. The digest is now ready for micro-Kjeldahl distillation.

The stainless steel bath containing carborundum grains has proved very satisfactory in use. Incidentally the suggestion is given that it might be worthwhile replacing with stainless steel the bottom plate of conventional copper clad, gas-heated ovens in order to give them a really long lease of life.

Dept. of Biochemistry, A. N. RAMANATHAN.  
Stanley Medical College,  
Madras-1, September 6, 1963.

### THE FIRST RECORD OF SMALL FLAKE-TOOLS AND POLISHED STONE CELTS IN KANGRA DISTRICT, E. PUNJAB

IN 1958 the senior author initiated through the Geological and Mineralogical Research Committee, C.S.I.R. (under the Chairmanship of Dr. D. N. Wadia) a research project: "*Explorations for the Remains of Early Man in India*". Its objective was to survey the Shivaliks of the East Punjab, the Karewas of Kashmir, the Narmada valley and the Kurnool region of South India in order to bridge the inexplicable lacuna—the complete absence of the physical remains of man more primitive than *Homo sapiens*.

The work was first commenced under the direction of the senior author by Dr. E. Khan, and is being continued by Dr. G. C. Mohapatra. As a member of the project, Dr. Khan brought



to light a rich assemblage of Shivalik vertebrate fossils, accounts of which have been published in a series of five articles under the general heading "*Recent Finds of Shivalik Vertebrates*" (Sahni and Khan, 1961). In addition, various accounts have been published by these authors (1963) on certain important aspects of the geology and structure of the area.

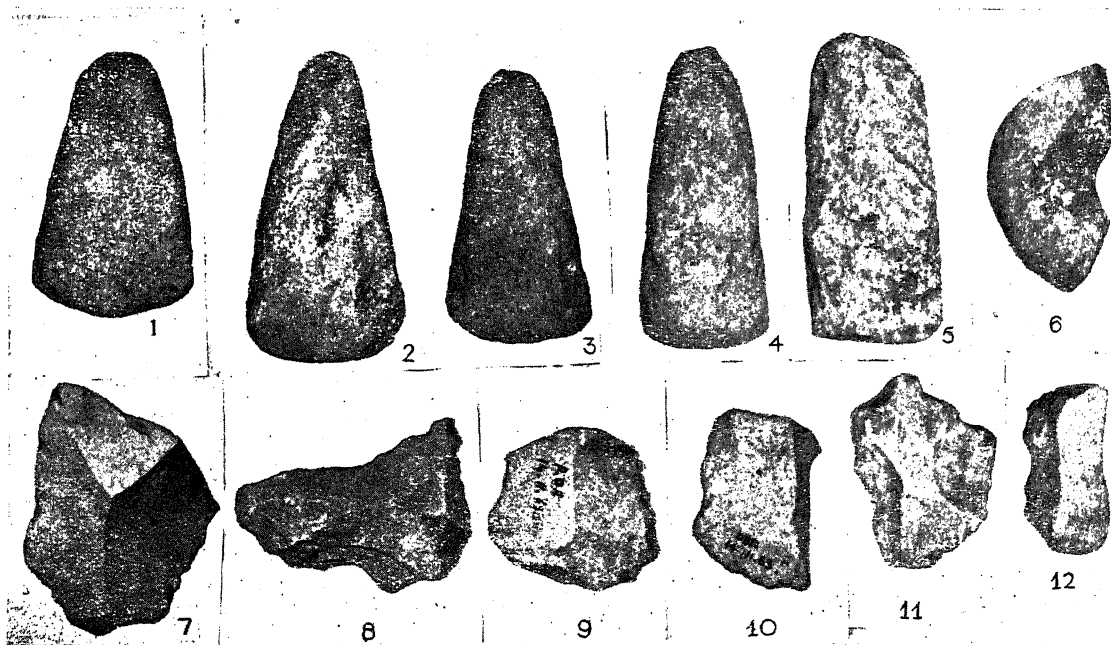
In course of field investigations carried out by the junior author under the above project (during October-November 1963) certain important finds were made and are dealt with in this note. Prior to these discoveries only one prehistoric culture, i.e., the Lower Palaeolithic Sohanian was known from East Punjab. A vast span of time between the Lower Palaeolithic and the Protohistoric Harappan cultures had remained unaccounted for. Therefore, prehistorians who tried to establish an India-wide correlation of lithic cultures and their chronological sequence presumed that the evidence available in Western Punjab extended across the political border. Despite this, the gradual development of prehistoric cultures in the order in which they appear in other parts of India, could not be worked out in East Punjab. This problem has been partly solved by the present discovery of a large number of small flake-implements and polished stone celts accompanied by ring-stones from the Dehragopipur Tehsil of

Kangra District. Typo-technologically these two groups of implements are to be placed between the Lower Palaeolithic and the Harappan cultures. This considerably reduces the gap mentioned above.

In course of the present field investigations, which included excavation of two trenches on Terrace 3 at Dehra, about five hundred Lower Palaeolithic Sohanian pebble artifacts were also collected at Nand, Chambaghat, Phera, Sunnet, Dehra, Bari, Maleta, Baughta and Sirha situated on the Beas, and at Guler, Haripur, Bangoti, Ror, Dibber and Jakkar in the valley of the Banganga, a tributary of the Beas.

The neighbouring fields on Terrace 1, 2 and 3, near the site excavated at Dehra, yielded a large number of Sohanian implements. A polished celt (Fig. 1) was found on Terrace 3 and a fossil tortoise bone (*Clossochelys atlas*) on Terrace 1. The latter is apparently derived from the adjoining Shivalik rocks.

About ten miles to the north-east of Dehra, in the valley of the Banganga near Haripur-Guler, Sohanian implements occur on the surface of Terraces 1 to 4. On Terrace 4 at Ror (left bank of the Banganga), about three and half miles downstream of Haripur bazar, thirty-one polished stone celts made of softish shale (Figs. 2 and 5), half of a ring-stone (Fig. 6) and over one hundred specimens of small chert



FIGS. 1-12. Polished Celts and small Flake-Tools from Kangra District

flake-implements (Figs. 7-12) were picked up. Implements occur all over the terrace up to its fringe where the villages of Dibber and Bhatoli are situated.

Apart from bringing to light the two lithic industries so far unknown in this area, the present field investigations have broadened our sphere of information regarding the Sohanian industry of East Punjab concerning which our knowledge was somewhat meagre. In a collection of five hundred specimens belonging to this industry not one recalls, even faintly, the peninsular handaxe or *coup-de-poing* technique. Therefore, the whole problem relating to the presence of a handaxe-cleaver culture in the Punjab, specially in its eastern half, needs reappraisal in the light of the present data.

Department of Geology, M. R. SAHNI.  
Punjab University, G. C. MOHAPATRA.  
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#### ON THE AGE OF SOME CLAY DEPOSITS IN BIRBHUM DISTRICT WEST BENGAL

RECENT investigations in Birbhum District, West Bengal, have brought to light several new clay deposits which can be classified, according to age, under the following heads:

1. Kaolin type formed by alteration of felspars in Archæan granitic terrain.
2. Upper Gondwana clays.
3. Tertiary clays.

Clays of group (1) occur as lenticular deposits south of Suri over a stretch of six kilometres. These clays are white, non-plastic and contain admixtures of fine grains of quartz and flakes of mica and do not persist to depth.

Clays of group (2) are located over a stretch of four kilometres extending from Harmadanga to Kendpahari and are interbedded with sandstones (Dubrajpur beds) which are of Upper Gondwana age since plant fossils of species belonging to *Ptilophyllum* and *Tæniopteris* have been identified in them. The clays are non-plastic to semi-plastic and white to dull grey with sandy intercalations.

Clays of group (3) occur over an area of forty square kilometres beneath an overburden of gritty ferruginous sandstone, laterite or older alluvium. The maximum thickness of clay beds is proved to be over twenty metres in Makhdumnagar. Drilling in the area has shown

that the clays are underlain by the Rajmahal Traps. Their Tertiary age is confirmed by microfossils in them.

Geological Survey of India, C. KARUNAKARAN.  
Calcutta, October 12, 1963. M. G. RAO.

#### A NOTE ON THE HELMINTH PARASITES OF THE BLACKBUCK (ANTILOPE CERVICAPRA)

THE helminths that have been reported from blackbuck are *Moniezia expansa*,<sup>1</sup> *M. trigonophora*,<sup>2</sup> *Trichuris cervicapra*,<sup>3</sup> *Hæmonchus contortus*,<sup>4,5</sup> *Ostertagia circumcincta*, *O. trifurcata*, *Trichostrongylus retortaeformis*, *T. axei*, *T. colubriformis*, *T. vitrinus*,<sup>5</sup> *T. probelurus*, *Camelostomoxys mentulatus* and *Nematodirus spathiger*.<sup>6</sup> This note reports the occurrence of trematodes, among others, from this host encountered during the course of a survey of helminth parasites, apparently for the first time.

A female blackbuck, belonging to the State Zoological Garden at Barang (Orissa) which died on 3rd May 1963, was examined for intestinal helminths and 27 amphistomes and 15 nematodes, assignable to five species were encountered, viz., 6 specimens of *Carmyerius gregarius* (Looss, 1896) from rumen, 5 specimens of *Paramphistomum gotoi* Fukui, 1922, 5 male and 9 female specimens of *Hæmonchus contortus* (Rudolphi, 1803) from the abomasum, 16 specimens of *Homalogaster paloniæ* Poirier, 1883 and a female *Trichuris* sp. possibly related to *T. cervicapra*, Kreis, 1935, from the cecum.

Most of these parasites are known to occur in the domestic ruminants in North-East India,<sup>7</sup> and their presence in a wild host indicates that blackbucks, under natural conditions, may serve as a reservoir host.

Grateful acknowledgements are due to Dr. S. Willmott, Director, Commonwealth Bureau of Helminthology, for supplying the concerned literature, and to Mr. L. N. Acharya, Veterinarian of the Zoo, for supplying the material.

Parasitologist (Veterinary), M. M. PATNAIK.  
Bhubaneswar-3, September 16, 1963.

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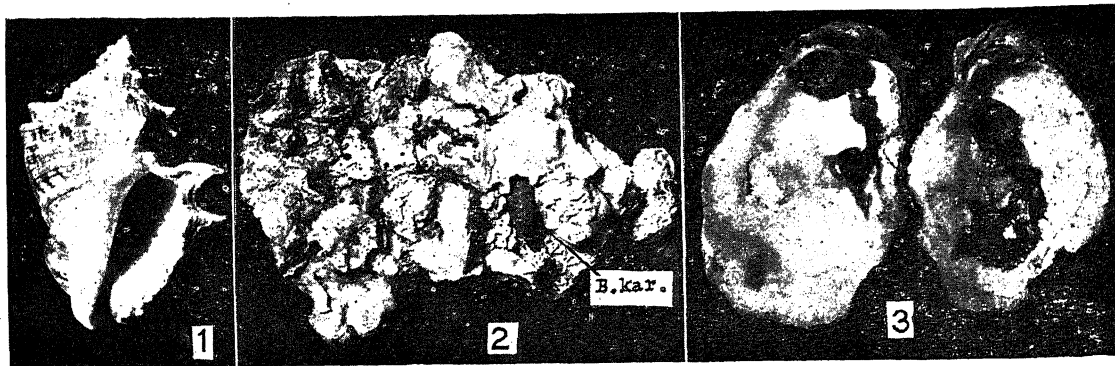
**MOLLUSCS AND POLYCHAETE  
WORMS CAUSING DAMAGE TO THE  
EDIBLE OYSTER, *CRASSOSTREA*  
*GRYPHOIDES* (SCHLOTHEIM)**

SOME molluscs and polychaete worms are known to cause extensive damage to oysters all over the world. During the study of the biology of the oyster *Crassostrea gryphoides* from an oyster farm near Bombay, three molluscs and Polychaete worms were observed to cause damage to the oysters in the farm.

noted from the internal faces of shells where they form mud blisters (Fig. 3). The first one was even observed swimming in the shell cavities of some oysters. The worm *Polydora* has been known to cause extensive damage to oysters elsewhere.<sup>3-4</sup> However, this worm has not been observed to be of any consequence in the case *O. (C.) madrasensis*.<sup>2</sup>

Department of Zoology,  
Institute of Science,  
Bombay, September 25, 1963.

V. S. DURVE.



FIGS. 1-3

The Gastropod, *Thais carinifera* (Fig. 1), belonging to the family Muricidae, was observed devouring the spat. Though the author himself did not observe it feeding on the adult oysters, the owner of the farm has stated having seen *T. carinifera* rasping away bits of shells from the gaping end of the adult oyster and devouring its meat. It may be mentioned in this connection that *T. haemastoma* has been known to cause damage to Florida oysters.<sup>1</sup> Pelecypods, *Brachyodontes karachiensis* Nelvill and *Modiolus striatulus* Linn., were also seen on the oyster farm. The former was often found to bore in the lower valves of adult oysters (Fig. 2) and the latter was seen attached with its byssus to the adult oysters and especially to the young spat, thus fouling and causing mortality of the spat. The occurrence of *Modiola undulata* on the spat of *Ostrea (Crassostrea) madrasensis*, has been recorded in India.<sup>2</sup>

The following three polychaete worms were commonly found in the oyster farm:

1. *Polydora caeca* Oersted.
2. *Perinereis nigropunctata* Horts.
3. *Perinereis aibuhitensis* Grube.

These worms were found boring and forming mud-tubes in oyster shells. They were also

\*Present Address: Central Marine Fisheries Research Institute. Mandapam Camp. S. India.

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**THE RHIZOSPHERE MICROFLORA OF  
RICE PLANTS AS INFLUENCED BY  
SOIL DEPTH AND ROOT MATURITY**

THE rhizosphere effect of rice plant and the influence of environmental conditions on the effect has been reported by some workers.<sup>1-3</sup> In the present report evidence is presented for the influence of soil depth and maturity of the root on the rhizosphere effect of rice plant.

For the purpose of these studies rice variety Co. 25 was grown in one cent plots under water-logged conditions in the University Experimental Farm. At periodical intervals the soil samples, together with the plant roots, were collected at random from the desired soil depth. From the sample the soil was carefully removed and the root bits separated. Two types of roots, the young ones which were whitish and

tender and the mature ones which were brown and rigid, were differentiated and sampled separately. Soil samples away from the plants from the same plot were also collected for comparison. Triplicate samples were taken up under each treatment for the studies. The root samples were prepared for microbiological analysis as per the method of Timonin<sup>4</sup> and the populations estimated using soil extract agar for the bacteria and actinomycetes and Martin's rose bengal agar for the fungi. The populations of bacteria, actinomycetes and fungi in soil layers as compared to those in the rhizosphere of young and old rice roots are presented in Table I. The rhizosphere effects in the young and old roots at different stages of plant growth, collected from different soil depths, are compared in Table II.

These results indicate that the rhizosphere effect varied with (1) maturity of root, (2) depth of soil wherefrom the root sample was collected, (3) age of the plant and (4) the group of the micro-organism concerned. When the root samples were collected from different soil depths, the effect was progressively more in the deeper layers, in both the young and old roots. In the young roots the effect was more on bacteria, which increased gradually with soil depth. Almost a similar effect was found in actinomycetes, whereas in fungi the effect got reduced gradually and only when the plant matured there was a distinct increase in the effect at the 10 to 12 inch layer. In the old roots also the effect was more on bacteria, which progressively increased with soil depth, but the effect was only about half as intense

TABLE I

*A comparison of the microbial populations in the rice rhizosphere and soil*  
(Population expressed as 10 /g. of moisture-free soil)

Age of plant in days	Bacteria			Actinomycetes			Fungi		
	30	90	150	30	90	150	30	90	150
Young roots:									
0-2 inch layer	.. 321	440	490	7.7	8.6	8.0	0.44	0.40	0.49
8-10 "	.. —	217	380	—	5.0	4.4	—	0.06	0.05
Old roots:									
0-2 inch layer	.. —	248	245	—	19.1	26.0	—	0.48	0.52
8-10 "	.. —	178	170	—	13.0	17.9	—	0.16	0.15
Soil:									
0-2 inch layer	.. 28.4	20.1	15.5	3.7	2.9	2.8	0.21	0.08	0.07
8-10 "	.. 12.1	7.1	6.4	1.4	0.8	1.2	0.03	0.01	0.01

— = no roots found.

TABLE II

*Rhizosphere effect due to young and old rice roots collected from different depths of soil*

Depth of soil in inch	Rhizosphere effect of:								
	Bacteria			Actinomycetes			Fungi		
Age of plant in days	30	90	150	30	90	150	30	90	150
Young roots:									
0-2	.. 11.3	22.0	31.6	2.0	3.0	2.9	2.1	5.1	7.2
2-4	.. 13.1	22.7	34.7	2.1	3.3	3.0	1.9	3.0	2.8
4-6	.. —	32.8	35.8	—	3.3	3.1	—	3.4	2.4
6-8	.. —	32.2	52.4	—	2.6	3.0	—	4.0	4.6
8-10	.. —	30.6	59.4	—	6.3	3.7	—	3.0	4.8
10-12	.. —	—	69.1	—	—	3.4	—	—	56.0
Old roots:									
0-2	.. —	12.4	15.8	—	6.6	9.3	—	6.1	7.6
2-4	.. —	12.2	17.7	—	9.5	10.0	—	6.7	5.8
4-6	.. —	19.0	21.8	—	9.4	10.0	—	5.9	5.5
6-8	.. —	16.3	20.6	—	7.0	11.8	—	9.1	10.9
8-10	.. —	25.1	26.6	—	16.3	14.9	—	8.0	12.5
10-12	.. —	—	—	—	—	—	—	—	—

— = no roots found.

as in young roots; the effect on the actinomycetes and fungi was more in older roots which increased significantly with the age of plant. In the 30-day old plants the young roots had only a low rhizosphere effect while old roots were not encountered. In the 90-day old plants there was more rhizosphere effect than in the 30-day old plants and in the 150-day old plants the effect was maximum.

The increased rhizosphere effect in the deeper soil layers in both young and old roots seems to be mainly due to the low number of micro-organisms in the soil. The differences in the quantity and quality of the micro-organisms in the rhizospheres of young and old roots seem to be similar to the ones reported earlier by Rangaswami and Vasantharajan<sup>5</sup> for citrus plants. Also, there were indications for the downward transport of fungi and actinomycetes, from the surface to the deeper layers, being carried on the root surface; some of the fungi and actinomycetes encountered on the rhizosphere were different from the ones usually found in the soil samples from the corresponding deeper soil layers. These results suggest that when a plant is grown in a soil not only the roots selectively activate the soil micro-organisms through the rhizosphere effect but also the microflora are turned over from the surface to deeper layers.

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#### QUALITATIVE STUDIES OF SUGARS AND AMINO-ACIDS FROM THE ARIL OF LITCHI FRUIT

A CONSIDERABLE amount of work<sup>1-3</sup> has been done on different parts of *Litchi chinensis* (Gaertn.) Sonn., but no information is available about the nature of the sugars and amino-acids present in the aril of the fruit, either in the free or bound form. The present communication deals with the qualitative studies of the said constituents in the ethanol extract of the aril and the acid hydrolysate of the residue thus obtained.

Circular<sup>4</sup> as well as classical descending paper chromatographic techniques on Whatman Filter Paper No. 1 were employed for the detection of sugars and amino-acids. By visual observation of the intensity of coloured bands and spots produced after the treatment of chromatogram with spraying reagents, a rough idea about the relative amount of the constituents (represented by signs +, ++, +++) present in the solution could be obtained.

**Sugars.**—The aril was defatted with 40-60 pet-ether and then extracted with ethanol. The extract, after removal of the solvent under reduced pressure, was subjected to paper chromatography using *n*-butanol-ethanol-water (4 : 1.1 : 1.9) and *n*-butanol-pyridine-water (3 : 1 : 1) as the developing solvents and aniline acid phthala as well as orcinol (3%) in alcoholic hydrogen chloride (5%), as the spraying reagents. It revealed the presence of glucose (+++), fructose (++) and sucrose (+). It may be noted that orcinol reagent produces characteristic colours for ketoses and aldopentoses.

The residue obtained after ethanol extraction was hydrolysed with 10% sulphuric acid on a boiling water-bath for 15 hr. and filtered. The filtrate was again kept on water-bath and to it was added barium hydroxide till the pH reached to about 6; it was finally neutralised completely with barium carbonate and filtered. The filtrate, after being concentrated under reduced pressure to a small volume, was extracted with methanol, furnishing a sugar mixture, and the barium salt. Paper chromatography of the sugar mixture, using the same solvents and spraying reagents as mentioned above, indicated the presence of arabinose (+++), galactose (++) , xylose (+), rhamnose (traces) and an unidentified sugar (traces) which in all probability might be fucose. The barium salt obtained did not produce red precipitate with basic lead acetate, a test<sup>5</sup> for galacturonic acid. Instead it gave yellow precipitate after prolonged heating which suggests the presence of glucuronic acid. After removing barium from the salt by sulphuric acid, the resulting free acid was chromatographed in solvents ethyl acetate-pyridine-water-acetic acid (5 : 5 : 3 : 1) and *n*-butanol-acetic acid-water (2 : 1 : 1 & 4 : 1 : 5) giving double spot. As the galacturonic acid would have given only a single spot under the condition, the presence of glucuronic acid is very much indicated.

**Amino-Acid.**—The aril was homogenized with 75% ethanol, and filtered. The concentrated filtrate, which gave a positive ninhydrine

test, was subjected to chromatography by using *n*-butanol-acetic acid-water (4 : 1 : 5 and 100 : 22 : 50), *n*-butanol-water (saturated) and phenol-iso-propanol-water (14 : 1 : 5) as irrigants and ninhydrine (0.2% in acetone) as spraying agent. The following amino-acids could be identified :

lysine (+); leucine (++) ; valine (+);  
alanine (+++); glutamic-acid (++) ;  
serine (++) ; and proline (traces).

The residue obtained from the homogenate was hydrolysed with 8N hydrochloric acid for 24 hr. and filtered. The filtrate was neutralised with sodium hydroxide and chromatographed, using the above-mentioned solvents. Before running, the chromatogram was exposed to ammonium hydroxide (4N) in order to avoid trailing of the spots. The presence of the following amino-acids was indicated :

leucine (++) ; isoleucine (+);  
valine (++) ; tyrosine (+); alanine  
(+++); proline (+); aspartic acid  
(+++); threonine (++) ; arginine  
(+); lysine (++) ; and an unidentified  
(++).

M. I. H. FAROOQI.

National Botanic Gardens, K. N. KAUL.  
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#### NATURE OF PLOIDY IN THE PASTURE GRASS—*PENNISETUM* *CILIARE* LINN

*Pennisetum ciliare* (Syn. *Cenchrus ciliaris* Linn.)<sup>1</sup> is reported to be a polyploid possessing  $2n = 36$  chromosomes.<sup>2</sup> In its natural population, plants possessing various chromosome numbers ( $2n = 32, 34, 36, 40, 43, 44, 45$  and  $54$ )<sup>3-5</sup> have been reported, the lowest number so far reported for the species being  $2n = 26$ .<sup>6</sup> A form of this species with  $2n = 28$  chromosomes was also detected and studied for its chromosome configurations at meiosis. The 28 chromosomes of this plant in the P.M.C.'s showed on an average 1-3 trivalents and rest bivalents and 1-3 univalents (Patil and Singh, unpublished) suggesting, thereby, that there could be still far lower chromosome number plants of this

material approaching its diploid form in natural population.

Cytological observations carried out in this laboratory on the species, *Pennisetum ciliare* ( $2n = 36$ ) and on its  $F_1$  hybrid ( $2n = 54$ ) with *P. pedicellatum* Trin. ( $2n = 36$ ) have suggested that the species *P. ciliare* is largely autopolyploid in nature.

The meiotic studies on *P. ciliare* ( $2n = 36$ ) showed a frequency of chromosome associations as  $1.3_{IV}$ ,  $0.08_{III}$ ,  $15.3_{II}$  and  $0.08_I$  per cell and the range being  $0.3_{IV}$ ,  $0.1_{III}$ ,  $12.18_{II}$  and  $0.1_I$ . This would indicate, relatively, larger quadrivalent frequency per cell. The chromosome configurations per cell in the other species, *P. pedicellatum* ( $2n = 36$ ), were observed to be  $0.7_{IV}$ ,  $0.05_{III}$ ,  $16.5_{II}$  and  $0.05_I$ , with a range of  $0.2_{IV}$ ,  $0.1_{III}$ ,  $12.18_{II}$  and  $0.1_I$ . Chromosome associations per cell in their  $F_1$  hybrid ( $2n = 54$ ) at meiosis were observed to be  $0.6_{IV}$ ,  $0.1_{III}$ ,  $24.4_{II}$ ,  $0.6_I$  with a range of  $0.2_{IV}$ ,  $0.1_{III}$ ,  $21.27_{II}$  and  $0.1_I$ .

From the number of chromosomes observed in the hybrid during meiosis, it would appear that the hybrid plant arose from the union of unreduced 36-chromosome gamete presumably of the female parent, *pedicellatum* with a normal reduced 18-chromosome *ciliare* gamete.

From the quadrivalent and trivalent frequency which is numerically about the same in *pedicellatum* and in the hybrid and from the genetical studies on the  $F_2$  and  $F_3$  population which showed no occurrence of the recombinations of the parental species, it could be inferred that out of 54 chromosomes present in the  $F_1$ , a set of 36 chromosomes of *pedicellatum* appeared to have paired autosyndetically forming quadrivalents and trivalents to about the same extent as in the parental species, *pedicellatum*. The remaining set of 18 chromosomes of *ciliare* similarly might have paired autosyndetically forming 9 pairs.

The presumption of the functioning of the unreduced gamete on the female side of *pedicellatum* is amply substantiated by the morphological look of the  $F_1$ , the chromosome size differences, *pedicellatum* chromosomes being larger than *ciliare* ones, the frequency of quadrivalency and trivalency which was about the same in *pedicellatum* and in  $F_1$ , apomictic breeding system of *pedicellatum*<sup>7</sup> which is more favourable for the function of unreduced gamete, etc. Moreover, the meiosis in the male parent *ciliare* was observed to be normal and as such the possibilities of any of its pollen carrying double set of chromosomes may be remote. The

reciprocal cross was not possible because of the highly apomictic breeding behaviour of the male parent, *ciliare*.

Thus the preferential pairing of 18 chromosomes of *P. ciliare* present in the  $F_1$  among themselves strongly suggests that *P. ciliare* which is a polyploid forming high frequency of quadrivalency appears to be largely autopolyploid in nature although the possibilities of the cryptic differences differentiating its chromosomes are not ruled out.

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B. D. PATIL.  
AMAR SINGH.  
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## SELF-INCOMPATIBILITY ALLELES OF *OENOTHERA RHOMBIPETALA* NUTT.

SELF-INCOMPATIBILITY is one of the important mechanisms facilitating outbreeding in angiosperms. This note is a preliminary report concerning the genetics of self-incompatibility in *Oenothera rhombipetala* Nutt. (race Turner). Normal growth of pollen tubes in the style was used as the criterion of compatibility in these investigations. Pollen grains compatible with the style form long pollen tubes which grow as far as the base of the style. The incompatible pollen either does not germinate on the stigma or forms small tubes which remain confined to the stigmatic tissue. Detailed analyses of compatibility tests, to be published elsewhere, have revealed that *O. rhombipetala* also, like *O. organensis*,<sup>2</sup> has a gametophytic system of self-incompatibility where the incompatibility reaction depends upon the S alleles functional in the pollen. Furthermore, in this system of self-incompatibility the S alleles have an individual action in the style without any interaction, and the pollen tubes are unable to grow in the style which has any S allele in common

with the S allele of the tube. From compatibility tests among the parents and the progeny the parent plants could be classified into two groups, one having  $S_1$  and  $S_2$  alleles and the other having  $S_2$  and  $S_3$  alleles. The progeny obtained from the cross  $S_1S_2(\text{♀}) \times S_2S_3(\text{♂})$  segregated into two compatibility groups,  $S_1S_3$  and  $S_2S_3$ , and that obtained in the reciprocal cross,  $S_2S_3(\text{♀}) \times S_1S_2(\text{♂})$ , also segregated into two compatibility groups,  $S_1S_2$  and  $S_1S_3$ . In other words, the progeny obtained from the two parent compatibility groups ( $S_1S_2$  and  $S_2S_3$ ) segregated into three compatibility groups in all,  $S_1S_2$ ,  $S_1S_3$ , and  $S_2S_3$  (Fig. 1). Thus, the race Turner of *O. rhombipetala* has only three S alleles which is the minimum number of alleles required for the successful operation of *Nicotiana*<sup>1</sup> type of self-incompatibility.

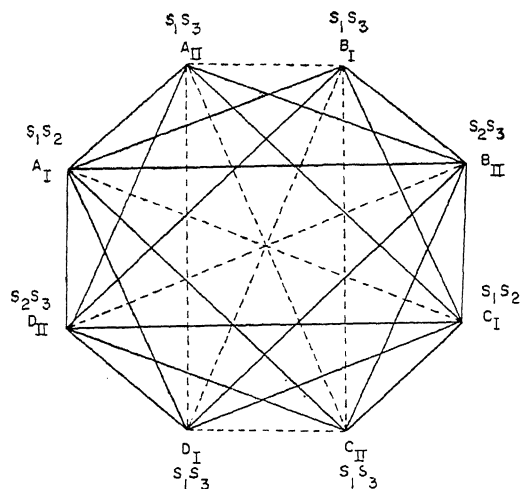


FIG. 1. Compatibility relationships obtained by pollen tube growth analyses in the progeny of crosses A, B, C and D. A and C are  $S_2S_3(\text{♀}) \times S_1S_2(\text{♂})$ ; B and D are  $S_1S_2(\text{♀}) \times S_2S_3(\text{♂})$ .  $A_I$  and  $A_{II}$  are two compatibility groups in the progeny of cross A and  $B_I$  and  $B_{II}$  in the progeny of cross B and so on. Solid lines indicate reciprocal compatibility; broken lines indicate reciprocal incompatibility.

Autotetraploids of this race of *O. rhombipetala* with  $S_1S_1S_2S_2$  and  $S_2S_2S_3S_3$  alleles were produced by colchicine treatment of the germinated seeds and seedlings by the method described by Hecht.<sup>3</sup> Autotetraploidy in the race Turner of *O. rhombipetala*, similar to the race Bridgeport,<sup>4</sup> does not result in breakdown of self-incompatibility. So far *Oenothera rhombipetala* is the only species with gametophytic type of self-incompatibility where tetraploidy does not result in any breakdown of self-incompatibility. This persistence of self-incompatibility in the auto-

tetraploids of *O. rhombipetala* can be explained due to a lack of competitive interaction between  $S_1$  and  $S_2$  and also between  $S_2$  and  $S_3$  alleles of heterogenic pollen grains.

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#### NITROGEN NUTRITION OF *RHIZOCTONIA SOLANI* KÜHN IN RELATION TO ITS OCCURRENCE ON ROOT SURFACES

In a study of fungi associated with root surfaces of groundnut (*Arachis hypogaea* L.) by the 'Serial root washing technique' of Harley and Waid (1955), *Rhizoctonia solani* was repeatedly isolated from washed roots of healthy plants of groundnut variety TMV 2. Although the fungus is a soil-borne plant pathogen attempts to induce disease in the above variety by the isolate ended in failure. The occurrence of the fungus on root surfaces is therefore considered to be due to rhizosphere effect. Since amino-acids are known to be excreted by legumes and they have marked influence on rhizosphere (Starkey, 1958) it is possible that the fungus may be utilizing such compounds on groundnut roots. This was tested by comparing the growth of the fungus on a medium with L-glutamic acid as nitrogen source with growth on nitrate nitrogen which is utilized well by *R. solani* (Wolf and Wolf, 1948).

The following basal medium was used:  $KH_2PO_4$  1 g., KCl 1 g.,  $MgSO_4$  0.5 g.,  $FeSO_4$ —Trace. Sucrose 30 g., Distilled water 1,000 ml. The medium was adjusted to a pH of 6.8 after adding nitrogen either as 2 g.  $NaNO_3$  or as 3.5 g. L-glutamic acid, which give equimolar concentration of nitrogen. Linear growth rate was measured on agar plates with above media. The fungus showed daily growth increment of 3.5 cm. on nitrate and 4.5 cm. on glutamate

indicating that the latter is a better source of nitrogen.

Growth in liquid cultures was determined as daily increase in dry weight. Basal medium with nitrate or glutamate was distributed in 25 ml. aliquots in 150 ml. flasks, sterilized and after cooling inoculated with 0.5 ml. mycelial suspension of the fungus prepared in a waring blender. Dry weight of five mats and pH of culture medium were determined daily from each nitrogen source. The results (Fig. 1)

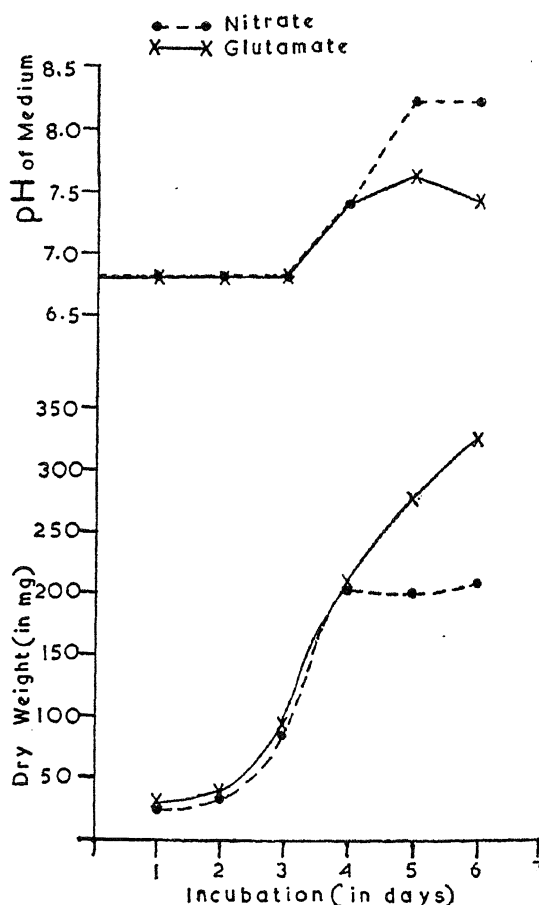


FIG. 1. Growth of *R. solani* and changes in pH of culture media with nitrate and glutamate nitrogen.

indicate no appreciable differences during the first four days. On the fifth day growth of the fungus on nitrate stopped completely and there was a simultaneous rise in pH of the medium to 8.2 whereas on glutamate growth continued and pH of the medium did not rise so steeply.

Amphoteric substances act as natural buffers in culture media (Lilly and Barnett, 1951) and



in this case L-glutamic acid appears to have exerted such an action making continued growth of the fungus possible. Similar effect can be envisaged in soil where plant roots, by their excretion products, may alter the pH. Thom and Humfeld (1932) and Katznelson and Richardson (1948) had demonstrated the protective action of plant roots in modifying soil pH in the direction of neutrality. It is quite likely that groundnut roots are favouring the growth of *R. solani* not only by providing it with nitrogenous substances but also by maintaining suitable pH for its continued growth.

We wish to thank Dr. V. S. R. Das for helpful suggestions.

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### A NEW SPECIES OF *Calcarisporium* PREUSS, FROM INDIA

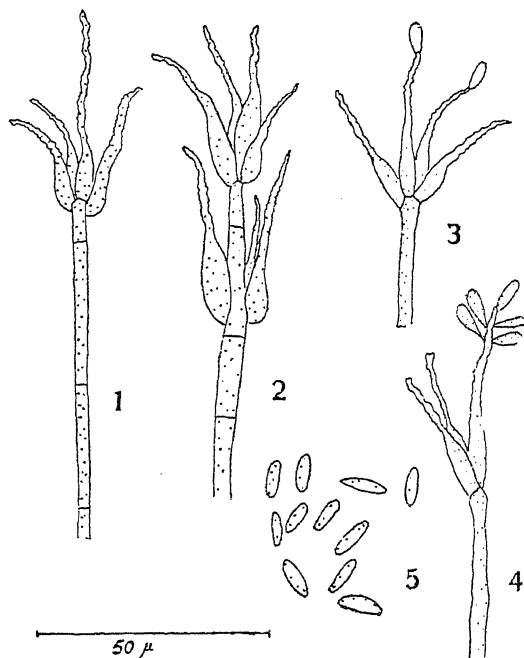
ALTHOUGH much controversy was prevalent regarding morphological characters and identification of the genus *Calcarisporium* Preuss. Hughes' (1951) redescrptions and discussions establish the validity of the same with *C. arbuscula* Preuss. as type. Barnett (1948) described *C. parasiticum* which was strictly parasitic on species of *Physalospora* Niessel., *Botryosphaeria* Ces and de Not., and *Coniothyrium* Corda. During the study of Hyphomycetes of Hyderabad, the authors collected a species of *Calcarisporium* growing as saprophyte from Nizamabad (Andhra Pradesh). It is obvious that this is not only the first record of *Calcarisporium* from India, but also an addition to the known ones.

*Calcarisporium indicum* sp. nov.

White to ash-coloured, irregular, subfloccose colonies are produced by this fungus. Creeping

hyphae hyaline, septate, branched, 2-5  $\mu$  broad, producing conidiophores. Conidiophores are erect, usually unbranched or rarely branched, septate, hyaline, 140-360  $\mu$  long, 2.5-7  $\mu$  broad. Branches arise from the main axis, subhyaline, 3-6-septate up to 150  $\mu$  long, 2-4  $\mu$  broad. Lageriform to obpyriform sporogenous cells arise in verticills of 3-5, either from the main axis or branches of conidiophores. They are subhyaline, 14-54  $\mu$  long, 4-7.4  $\mu$  broad at the base, gradually tapering with dentate to curved fertile apex. Conidia are produced acropleurogenously, singly or in groups, one-celled, subhyaline, cylindric-fusiform, 7.2-10.8  $\mu$  long and 1-3  $\mu$  broad.

Collected on old unidentified barks from Nizamabad by Dev Rao on 15-6-63, "Herb. Hyd." V.V.C.B.L. No. 303.



FIGS. 1-5. Figs. 1 and 2. Conidiophores with sporogenous cells. Figs. 3 and 4. Sporogenous cells with conidia. Fig. 5. Conidia.

Mention may be made here that although the type *C. arbuscula* was collected as mycoparasite on *Lachnella* Fr., collections were made later, on dead oak woods also. The present fungus differs from *C. arbuscula* and *C. parasiticum* in the measurements of sporogenous cells, conidiophores, conidia and hence described as new *Calcarisporium indicum*.

*Calcarisporium indicum* sp. nov.

Coloniae irregulare, subfloccosae, mycelium hyalinum, septatum, ramosum, 2-5  $\mu$  latum.

Conidiophori erecti, simplices vel ramosi, septati, 140-360  $\mu$  longi, 2.5-7  $\mu$  lati, hyalini, ramuli, 3-6 septati, usque 150  $\mu$  longi, 2-4  $\mu$  lati, producti cellulæ sporogenæ. Cellulæ sporogenæ lageniformæ vel obclavatæ, 3-6 verticillatæ, basali sterili, apicali fertili, denticulatæ, 14-54  $\mu$  longi, hyalini. Conidia continua, acropleurogena, 7.2-10.8  $\mu$  longa, 1-3  $\mu$  lata, hyalina vel subhyalina, cylindræa vel fusiformia.

Typus lectus in ligno emortio in loco Nizamabad, die 15. mensis Junii, anni 1963, a Dev Rao et positus in Herbario Hyderabadensi V.V.C.B.L. subnumero 303.

We thank Prof. M. R. Suxena, Osmania University and Dr. S. D. Satwalekar, Principal, Vivek Vardhini College, Hyderabad, for providing facilities and encouragement.

Dept. of Botany, DEV RAO.  
Vivek Vardhini College and RAGHUVeer RAO.  
Nizam College,  
Hyderabad (India), September 6, 1963.

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### AN ABNORMAL ARECA PALM (ARECA CATECHU)

An interesting but abnormal instance of a tree was noted in the arecanut garden of Shri C. M. Varghese at Chalisseri in Palghat District. On this ten-year-old tree it was observed that each of the inflorescences instead of producing the normal spadix-bearing male and female flowers

and fruits had developed directly into seedlings (Fig. 1). The tree was bearing twelve seedlings in which the peduncle itself was transformed into a seedling which remained attached to the mother palm till it dried up. One of the seedlings was found to have reached a size of 3' 5" bearing five normal leaves on it. The stem and leaves are conspicuous while roots are completely absent. The seedlings bear infertile inflorescence after 6 to 7 leaves have been produced (Fig. 2). On dissecting the abnormal seedling's inflorescence only male flowers have been observed. After producing a certain number of leaves in this manner during a period of over two years, the central shoot withers and the whole seedling dies.

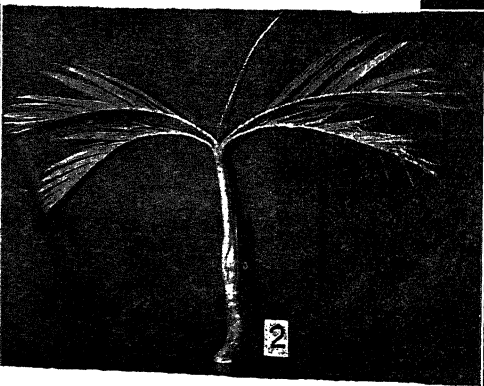
On cutting open the spathe in a young inflorescence it is seen that the branches and branchlets which should have borne male and female flowers are replaced by young leaflets of a creamy-white colour (Fig. 3). Further studies will have to be made to find out how the seedlings arise in place of male or female flowers.

Trials are being conducted to promote rooting of the seedlings and four of these have been detached from the mother tree and planted in pots.

Thanks are due to Prof. L. S. S. Kumar for his encouragement and help in preparing the note for publication.

Division of Plant Pathology,  
Agricultural College and  
Research Institute,  
Vellayani, Trivandrum,  
Kerala, September 23, 1963.

ABI CHEERAN.



FIGS. 1-3. Fig. 1. The parent tree bearing the abnormal seedling (21-year old) with five leaves and two infertile inflorescence. Fig. 2. The abnormal seedling before emerging from the spathe. Fig. 3. The abnormal inflorescence

## MOLYBDENUM DEFICIENCY IN CITRUS

A STUDY was undertaken to see the effects of molybdenum deficiency in the seedlings of Rough Lemon (*Citrus jamburi*) which is gaining popularity as a useful root stock in a number of citrus tracts in India.

Seeds were sown in purified quartz sand and twenty-day-old seedlings were transferred to wax lids floating in triple distilled water. This technique of raising the seedlings was adopted for rapid induction of the symptoms. The seedlings were allowed to grow for another ten days and then transferred to respective culture solutions that of control and molybdenum deficient.

The solutions of salts supplying major nutrients  $\text{Ca}(\text{NO}_3)_2$ ,  $4\text{H}_2\text{O}$ ,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ,  $\text{KNO}_3$ , and  $\text{KH}_2\text{PO}_4$  were purified by the technique described by Hewitt.<sup>1</sup> Iron was added in the form of iron citrate (0.5% solution) at the rate of one ml. per litre once every week. Molybdenum-free iron citrate was obtained by the technique involving chelation (with dithiol) as described by Hewitt.<sup>1</sup> The pH of the nutrient solution was maintained between 6.0 and 6.5. The culture solutions were changed once every fortnight and the cultures were aerated every day.



FIG. 1. Progressive development of foliar symptoms due to molybdenum deficiency in citrus.

The symptoms which developed within about fifteen days were as follows:

The plants under molybdenum deficiency were dwarfed, the expansion of the upper leaves was reduced and they were rough in texture. The leaves developed mottling as pale white circular spots with dark points in the centre. These spots later coalesced to form large areas extending all along the lamina. The tissues in these circular spots showed necrosis and collapsed so that finally these appeared as depressions when examined under lens. As the deficiency progressed, the leaf tip died out and margins got curled up. The leaves showing

pronounced symptoms of scorched tip and upcurled margins did not abscise (Fig. 1). Further, the interesting feature was, that the deficient plants had stunted, thicker roots with swollen tips and bore tertiary laterals which were absent in the control (Fig. 2). In our

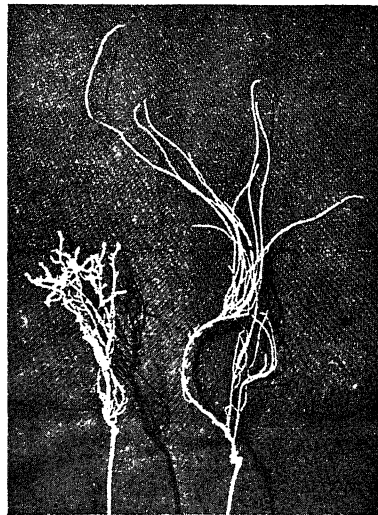


FIG. 2. Right: Control; Left: Molybdenum deficiency, cultures water-soaked areas, carrying gum on lower surface and eventual shedding of the lower leaves as described by Stewart and Leonard<sup>2</sup> in the citrus orchards of Florida were not observed.

The authors are indebted to Prof. R. D. Asana for his valuable suggestions.

Division of Botany,  
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VED PARKASH.  
H. K. SAXSENA.

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## OCCURRENCE AND INHERITANCE OF 'GRASS-CLUMP' CHARACTER IN WHEAT

In the progeny of normal  $F_1$  plants of two crosses, viz., N.P. 823  $\times$  Yaqui-53 and Pb. C. 273  $\times$  H.P. 27-156, a number of plants were observed to be grass-clumps in the  $F_2$  generation. The seed after germination emerged normally and the seedlings thus obtained were quite identical with the normal plants. But after two to three weeks a number of seedlings developed more and more leafy growth and took the shape of grass-clumps. Leaves at this stage were smaller, stiffer and leathery. The grass-clumps survived for 3-4 weeks and then started withering and ultimately resulted in the total mortality of such plants.

TABLE I  
Mode of inheritance of grass-clump habit in two intervarietal crosses of wheat

Cross and Generation		Number of plants/families			Total	$\chi^2$	P. value
		Normal	Heterozygous	Grassy			
N.P. 823 × Yaqui-58	F <sub>2</sub>	395	..	80	475	0.6837	0.30-0.50
"	F <sub>3</sub>	22	22	..	44	0.2642	0.80-0.90
N. 273 × H.P. 27-156	F <sub>2</sub>	365	..	65	430	1.5629	0.20-0.30

The withering process was enhanced because of the fact that most of the plants including the grass-clumps were highly susceptible to brown rust to which they succumbed in the seedling stage. Data collected on the inheritance of dwarfism in these crosses are summarised in Table I.

All the parents which entered the two crosses and the F<sub>1</sub> plants were normal indicating thereby that the grass-clump character in wheat is recessive in nature. It would be observed from Table I that the F<sub>2</sub> data in both the crosses gave a good fit to 13 normal : 3 grass-clump ratio which indicated the operation of one dominant pair of factors for grass-clump formation along with a pair of inhibitory factors. The results obtained in these two crosses are in agreement with those reported earlier.<sup>1-3</sup>

Botany Division, P. N. NARULA.  
I.A.R.I., New Delhi-12. V. S. MATHUR.  
August 29, 1963. P. S. L. SRIVASTAVA.

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#### EFFECT OF NAA ON CHLOROPHYLL AND CAROTENOID CONTENTS OF MAIZE (*ZEA MAYS*) SEEDLINGS

THE observations<sup>1,2,3</sup> that application of synthetic phytohormones deplete the total carbohydrate contents of the treated plants, suggest the possibility of decreased pigment development following such treatments. In the course of present investigation, therefore, an attempt has been made to study the influence of presoaking the seeds in 5 p.p.m. of NAA ( $\alpha$ -Naphthalene acetic acid) solution on the chlorophyll and carotenoid contents of maize saplings.

Seeds of maize T. 41 were partly immersed in Petri dishes in 5 p.p.m. of NAA solution for 24 hr. at 30°C. Seeds soaked in distilled water for 24 hr. were used as control. Immediately after the soaking, the seeds were sown in earthen pots filled with acid-washed sand. The seedlings were raised up to 15 days and were irrigated with normal Knop's solution. Chlorophylls and carotenoids were analysed

following the procedure suggested by Frank and Kenny.<sup>1</sup> Five grams of fresh shoots from each sample were ground with a little acetone, quartz and calcium carbonate in a mortar to a thin paste. The resultant slurry was filtered in a Buckner funnel under suction, adding a little of 85% acetone from time to time till the total pigments were extracted. The filtrate was then made to 100 ml. The extraction was performed in dark to check decomposition. Triplicate extractions were made for both control and treatment. Finally, the optical density of each was determined with a photoelectric colorimeter at 440 m $\mu$  and at 660 m $\mu$ . Observations were recorded after 4, 10 and 15 days of treatment.

The amounts of chlorophylls and carotenoids in mg./g. of fresh shoot weight are given in Table I.

TABLE I

Days after sowing	Control		Treated	
	Chlorophylls	Carotenoids	Chlorophylls	Carotenoids
5	0.45	0.022	0.028	0.020
10	0.052	0.024	0.038	0.022
15	0.052	0.024	0.050	0.024

The data show a marked decrease in chlorophyll contents of the treated seedlings. The maximum decrease takes place after 5 days, but it shows a tendency to recover later. Carotenoids were, however, not effected significantly.

The author is thankful to Dr. S. N. Bhardwaj, and Dr. A. B. Gupta for encouragement.

Department of Botany, V. S. RATHORE.  
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## REVIEWS

**Chemical Spectroscopy.** By R. E. Dodd. (Elsevier Publishing Co., Amsterdam), 1963. Pp. x + 340. Price £ 2-8-0.

The book under review is intended to enable the reader to obtain a general grasp of the basic methods and principles of spectroscopy and their application to the solution of chemical problems. This is an ambitious programme, but the book succeeds admirably in carrying it through. It is not a bulky tome, covering as it does only 340 pages of text, including the index. Within this relatively small compass to have covered the wide range of spectroscopic techniques which have necessarily to receive attention and the diversity of the chemical problems which have also to be dealt with has been possible only by reason of the author's great didactic gifts combined with his deep knowledge of the fields covered by the book. Particularly noteworthy is the skill shown in keeping the basic principles in the foreground and presenting them clearly and succinctly instead of allowing them to be swamped by a mass of detail. The entire subject has been handled in such a manner that an undergraduate student will find a perusal of its pages attractive and exciting and derive both pleasure and profit from a detailed study of it. Likewise, to the teacher who wishes to develop the subject in a systematic course of lectures and convey to his listeners a solid basic knowledge of the subject, the treatment given in the book would be most suitable for the purpose. The book is highly commended.

C. V. R.

**Modern Developments in Audiology.** Edited by James Jerger. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xii + 446. Price \$ 12.00.

The subject of physiological acoustics entered upon a new phase when instruments known as audiometers were devised which were capable of measuring the sensitivity of the human ear to sound over the entire range of pitch accessible to human hearing. The usefulness of such measurements in the study and treatment of hearing defects will be obvious when we recall the parallel case of vision and the methods employed by the ophthalmologists.

The volume under review is intended to be a survey of the more important findings of

research in recent years in the fields opened up by audiometry. There are eleven articles covering a wide range of subjects. Nine articles are by authors in the U.S.A., one is by a Danish investigator who deals with the subject of 'Middle-Ear Muscle Reflexes in Man' and another by two Italian authors in collaboration who consider the 'Central Hearing Processes'. Audiometers make it practicable to make extensive surveys of human populations for hearing defects. Quite naturally, in the early phases of the subject, the methods to be adopted in making such surveys and the difficulties met with in obtaining reliable data have received much attention. The particularly difficult case of the measurement of hearing in children may be mentioned in this connection. The physiological aspects of hearing, *viz.*, auditory fatigue and masking and auditory adaptation are dealt in two chapters. Finally, it may be remarked that the human aspect of the subject is brought into relief by the subject of functional hearing loss. When is this real and when is it only malingering or just mere pretence?

C. V. R.

**Enzyme and Metabolic Inhibitors (Vol. 1).**

Edited by J. L. Webb. (Academic Press, New York and London), 1963. Pp. xxi + 949. Price \$ 26.00.

The first volume of a four-volume series on *Enzyme and Metabolic Inhibitors*, which has over 900 pages and lists 16,000 references, is an encyclopædic survey of the subject. In refreshing contrast to the present trend towards compilation of reviews by different authors, this series is the work of a single author. This subject is of increasing importance in biochemistry and medicine, pharmacology and industry. The number of publications on malonate and iodoacetate for instance has increased from 13 in 1920-1930 to over 1,200 in 1950-1960. These volumes are intended as a comprehensive treatise on inhibitors. The first volume deals with the general principles of enzyme inhibition and the subsequent volumes will deal with individual inhibitors in detail.

The initial chapters deal with kinetics, classification and analysis of different types of inhibition, substrate and product inhibition and interaction of inhibitors with enzymes. The chapters

on the determination of the mechanism and of constants, the localisation of the site of inhibition, planning and reporting of inhibition studies and on the plotting and interpretation of data will be found particularly useful by students and research workers. The chapter on interaction of inhibitors with enzymes will also be invaluable to students for understanding the theory of inhibitor action. Other chapters deal with inhibition in multi-enzyme systems, specificity, the effect of more than one inhibitor and the effect of pH and other factors. The chapters on the effect of inhibitors in living organisms and in cells and tissues are a useful supplement to the more extensive ones on *in vitro* studies. This brief outline indicates the comprehensive scope of the introductory volume. There are a few minor misprints but the get-up of the volume is on the whole attractive. It is to be regretted that the treatment of feedback systems and of other control mechanisms which are a vital part of the metabolism of the cell or tissue is extremely brief. The association and dissociation of the sub-units of glutamic dehydrogenase, which is influenced by nucleotides and other substances, may be a mechanism by which inhibitors can act and might also have been discussed at greater length.

This volume is on the whole an excellent treatise on general principles of inhibitors which summarizes and correlates the extensive literature in this field and may well become an authoritative text for research workers in biochemistry and related subjects.

V. J.

**Advances in Marine Biology**, Vol. 1. Edited by F. S. Russell. (Academic Press, London and New York), 1963. Pp. 410. Price 84 sh.

The acceleration of progress in the different branches of science in recent years has made it difficult for scientific workers to keep in view the continually moving frontiers of even their own fields of specialization. To meet this situation, serial publications have been produced during the last fifteen years, reviewing annually the advances in the different fields. The latest addition to this growing family of "Advances" is the book under review, *Advances in Marine Biology*.

The publication of this new serial indicates that marine biology, a comparatively young science, has now come of age. Another serial publication under the title, *Annual Review of Oceanography and Marine Biology*, edited by Dr. H. Barnes, has been brought out by George

Allen & Unwin. The two publications, however, are planned on different lines and deal with complementary aspects. It is evident that the science of the sea has several growing points, and the publication of more than one serial has become necessary.

But what is marine biology? Is it the biology of the sea or biology of marine animals? There is certainly some distinction between the two connotations, chiefly in regard to what they emphasise. Whatever that may be, Dr. Russell has adopted the latter connotation and has accordingly presented a judicious, necessarily limited, selection of outstanding contributions in different fields of the biology of marine organism.

Marine biologists have long felt the need for developing methods for successfully rearing larvae and juveniles of different marine organisms. This is a particularly difficult task in the case of bivalves. Loosanoff and Davis have achieved what was regarded as virtually an impossible task. It is indeed a great achievement, which they have reviewed, based on twenty years' continuous work and an ingenuity of designing and construction of various apparatus for physiological studies.

A posthumous paper by the reputed oceanographer and marine biologist, Anton F. Brunn, discusses the controversy regarding the breeding of the North Atlantic Freshwater Eels. In recent years D. W. Tucker has proposed a new hypothesis regarding the eel problem, rejecting the well-founded conclusions of Schmidt. According to Tucker the European eels do not return to the Sargasso Sea but perish in their own continental waters, and that the populations of the European eels *Anguilla anguilla* are entirely maintained by reinforcements of larvae of American '*A. rostrata*' parentage. Brunn presents a wealth of detailed arguments in support of Schmidt's hypothesis.

The vision of fishes is a field which is being intensively investigated of late and in which several new facts have come to light. Nicol has given a comprehensive review of ethological, ecological, and physiological studies relating to vision in fishes, including the physiology of rhodopsins, the function of the choroidal gland as a rete mirabile (concerned with supply of oxygen to the retina), etc.

The biology of the coral reefs and the behaviour and physiology of clupeid fishes are surveyed in the remaining two chapters. Prof. C. M. Yonge has reviewed all recent literature on the biology of coral reefs, ranging from taxonomy to production. The clupeids are a

very successful group of fishes and present great adaptability to a wide variety of environmental conditions, and have also a complex racial system. J. H. S. Blaxter has planned his review of the behaviour and physiology of herring and other clupeids from a new angle, starting with fertilization of the egg and larval stages and ending with maturation and spawning.

The Editor, Dr. Russell, has accomplished a valuable task. The value of the book is much more than that of a routine review or survey. The presentation of the matter is thought-stimulating, and new areas of investigation suggest themselves to a careful reader of the book. Marine biologists are indebted to Dr. Russell and the publishers for this new landmark in the literature on marine biology. We trust that the future volumes of the *Advances in Marine Biology* will explore more and more new vistas including problems bearing on the genetical and evolutionary aspects of marine organisms.

R. V. SESHAIYA.

**Insect Pathology—An Advanced Treatise, Vol. 2.**  
Edited by E. A. Steinhaus. (Academic Press, New York and London), 1963. Pp. xiv + 689. Price \$ 23.00.

This is the second volume of an important work of which Volume 1 appeared sometime ago.

The present work is divided into 17 chapters which are contributed by 19 different authorities. It deals with various insect diseases caused by bacteria, fungi, protozoa, nematodes and insect parasites themselves. The scope of the work will be best evident by detailing the subjects dealt with in the individual chapters. These are: Taxonomy of entomogenous bacteria, diseases caused by spore-forming bacteria, the milky disease, non-sporulating bacterial pathogens, *Coelomomyces* infections, Entomophthorales infections, diseases caused by Hyphomycetous fungi, *Cordyceps* infections, sporozoan infections, infections caused by Protozoa other than Sporozoa, nematode infections, pathologies caused by insect parasites, epizootiology of infectious diseases, microbial control, commercial productions of insect pathogens, diagnosis of insect diseases, and, finally, techniques in insect pathology.

Each chapter is written in an advanced way and more or less independently of the others. This has resulted in a certain amount of overlap which, however, is desirable in order that each of the subjects is dealt with comprehensively.

At the end of each chapter is given an extensive bibliography on the subject. Towards the

end of the book we find an author index and a very comprehensive subject index which helps in tracing any information without loss of time.

The book is adequately and excellently illustrated by several diagrams and photographs and is printed beautifully and bound in fine, strong, brown cloth.

Along with Volume 1, the present volume forms a very comprehensive and advanced introduction to the subject of insect pathology which is of interest to all biologists, and particularly to economic entomologists for purposes of control of insect pests of agriculture and forestry. We recommend the book wholeheartedly for zoological libraries as well as for libraries of agricultural and forestry institutions.

M. L. ROONWAL.

**The Enzymes (Vol. 7, Part A).** Edited by P. D. Boyer, H. Lardy and K. Myrback. (Academic Press, New York and London), 1963. Pp. xxi + 726.

The seventh volume of the revised eight-volume edition of *The Enzymes* deals with pyridine nucleotide- and flavin-enzymes. It consists of twelve chapters on pyridine nucleotide-enzymes and fourteen on flavin-enzymes including one survey article. A few of the chapters (e.g., those on oxidation reduction of nucleotide-linked sugars and hydroxy steroid dehydrogenases) deal with a group of enzymes whereas most of the other chapters deal with individual enzymes which have been extensively studied. There are chapters on glutamate, alcohol, glycerophosphate,  $\beta$ -hydroxy acyl CoA, isocitrate, aldehyde, malate, glucose-6-phosphate and 6-phosphogluconic dehydrogenases. The flavo-protein enzymes include two excellent chapters on lipoyl dehydrogenase and pyruvate and  $\alpha$ -keto glutarate oxidation enzymes which should be read together. Other chapters deal with succinate, acyl CoA and lactate dehydrogenases, electron transport flavoprotein, old yellow enzyme, xanthine, glucose and amino-acid oxidases, nitrite, quinone and cytochrome reductases.

The high standard of the previous volumes of this series has been maintained and the difficult task of reviewing the extremely rapid increase in the literature on these enzymes has been ably carried. However this volume is not an encyclopædic survey and deals only with those enzymes which have been extensively purified or very thoroughly studied. There is considerable variation between the individual chapters. Some of the chapters, such as those

on glyceraldehyde phosphate, alcohol and glutamate dehydrogenases, are comprehensive reviews of the voluminous literature on these enzymes, whereas others are more cursory in their treatment of the subject. Owing to the rapid progress in this field, some recent discoveries such as ferredoxin find no place in this volume and it would be worthwhile if supplements can be published periodically which survey major developments after every two or three years. This volume along with the preceding volumes is invaluable for students and specialists and should find a place in all biochemical libraries.

V. J.

### Books Received

*Techniques in Endocrine Research.* Edited by P. Eckstein and F. Knowler. (Academic Press, New York), 1963. Pp. xvi + 319. Price 63 sh.

*Temporal Organization in Cells—A Dynamic Theory of Cellular Control Processes.* By B. C. Goodwin. (Academic Press, London N.W. 1), Pp. x + 163. Price 37 sh. 6 d.

*Germfree Life and Gnotobiology.* By T. D. Luckey. (Academic Press, New York), 1963. Pp. xii + 512. Price \$17.50.

*World Academy of Art and Science—The Population Crisis and the Use of World Resources.* Edited by S. Mudd. (Dr. W. Junk, Publishers, The Hague, Netherlands, 13 Van Stolkweg), 1964. Pp. xix + 562. Price Dutch guilders 35; \$9.00.

*Medicinal Chemistry—A Series of Monographs (Vol. L)—Diuretic Chemistry and Pharmacology.* By George De Stevens. (Academic Press, London W. 1), 1963. Pp. xiii + 186. Price \$7.00.

*Advances in Astronomy and Astrophysics (Vol. 2).* By Zdenek Kopal. (Academic Press, New York-3, N.Y.), 1963. Pp. xi + 314. Price \$11.5.

*Comparative Endocrinology.* Edited by U. S. Von Euler and H. Heller. (Academic Press, New York-3, N.Y.), 1963. Pp. xiii + 282. Price \$12.00.

*The Genera of Fishes and a Classification of Fishes.* By D. S. Jordan. (Stanford University Press, Stanford, California), 1963. Pp. xvi + 800. Price \$17.50.

*Experimental Pharmacogenetics—Physiopathology of Heredity and Pharmacologic Responses.* By Hans Meier. (Academic Press, New York), Pp. xi + 213. Price \$7.50.

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## SCIENCE NOTES AND NEWS

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### Award of Research Degree

Utkal University, Bhubaneswar, has awarded the Ph.D. Degree in Agricultural Botany to Shri D. V. Seshu, Assistant Botanist, Central Rice Research Institute, Cuttack, for his thesis entitled "Cytogenetical Investigations in the Interspecific Hybrids of Genus *Oryza*".

### Symposium on Crustacea

A Symposium on Crustacea under the auspices of the Marine Biological Association of India will be held during the second week of January 1965 at Cochin primarily to review the present position, discuss the problems and plan for future research about these important group of animals. It is suggested for the purpose of the Symposium to cover the systematics, biology and fishery of the extant forms of Crustacea. The exact dates will be intimated to participants in due course. Those desirous of contributing papers should send the abstracts in duplicate so as to reach the Convener by August 14, 1964 and the full papers on or before November 15, 1964.

Further particulars can be obtained from the Convener, Symposium, Marine Biological Association of India, Marine Fisheries P.O., Mandapam Camp, S. India.

### International Conference on Polynology

The Second International Conference on Polynology will be held at the State University, Utrecht, Netherlands, August 29 to September 5, 1966. Excursions to localities in Holland, Belgium and West Germany are planned. Inquiries should be directed to Professor Dr. F. P. Jonker, Botanical Museum and Herbarium of the State University, Lange Nieuwstraat, 106, Utrecht, Netherlands.

### Dichlorvos—A Promising Insecticide

Malarialogists are constantly on the look out for new insecticides, because of the development of resistance by mosquitos to those generally used in eradication campaigns. Dichlorvos, i.e., 0, 0-dimethyl-2, 2-dichlorovinyl phosphate (DDVP), a liquid organophosphorous compound, which is volatile and can be employed



as a fumigant, shows particular promise. It has undergone preliminary field trials at malaria eradication in several African countries.

A special advantage of dichlorvos is that it can be combined with solid substances, such as wax, which can then be fashioned into dispensers (rolls, briquettes, tablets or cylinders) from which it slowly evaporates, leaving a sufficient concentration in the air to kill mosquitos without being harmful to man.

Laboratory tests have confirmed the absence of short-term toxicity for man at doses that are biologically effective against mosquitos, i.e., between 0.01 and 0.15  $\mu\text{g.}$  per litre of air for anophelines, and 0.02-0.03  $\mu\text{g./l.}$  of air for flies. —(WHO Chronicle, January, 1964.)

#### Hydrogen in Intergalactic Space

Direct evidence of the presence of hydrogen in intergalactic space has been reported by Dr. Robinson of the Radiophysics Division, Sydney, Australia, and his associates. They looked for hydrogen radio signals in the 21 cm. wavelength band from the galactic cluster Virgo. Virgo is a cluster of more than thousand galaxies extending a distance of 2 million light-years through space and located 30 million light-years from our galaxy (the Milky Way).

The successful performance of the Australian investigation required not only a giant radio-telescope but also a highly sensitive microwave receiver. Dr. Robinson and his team have been at work for the past two years devising and perfecting such a detector to respond to the radiation from hydrogen atoms in the narrow 21 cm. wavelength band. Measurements made with this instrument in conjunction with the Division's 210 ft. diameter radio-telescope at Parkes, New South Wales, provided the first evidence of the existence of intergalactic hydrogen.

Modern cosmological theories of the evolution of the Universe assume the principal matter of the universe to be hydrogen from which galactic clusters originally formed, and from these galaxies the stars eventually condensed. Two questions of a fundamental nature arise. Are new galaxies undergoing formation? Is there hydrogen gas between the galaxies, and in intercluster space, out of which they might form? Until quite recently we had no evidence that any of the gas might be left.

Evidence for the presence of interstellar hydrogen, that is hydrogen between the stars, in our galaxy was obtained, in 1951. Interstellar hydrogen in a galaxy outside our own, the Milky Way, was first detected in 1953, in the

Megallan clouds, 150,000 light-years away. The Virgo cluster of galaxies, which concern the present discovery, is 200 times further away.

The discovery of the presence of hydrogen in intergalactic space is of great significance from the point of view of the new theories connected with birth and evolution of the Universe.

The hydrogen gas detected in Virgo is incredibly thinly distributed. An idea of how progressively scarcer its distribution becomes in the further reaches of space, can be had from the following: Our atmosphere around the earth contains about  $10^{20}$  molecules per cubic inch. The interstellar gas of the Milky Way has only 10 hydrogen atoms per cubic inch. The space between the galaxies in Virgo has been estimated to contain only one hydrogen atom to 10,000 cubic inches. Yet the size of the cluster is so great that the total amount of hydrogen is equal to the mass of 10 large galaxies!—(Australian Science News Letter.)

#### Underground Explosion Detection

A new approach to the problem of distinguishing between earthquakes and underground nuclear explosions is being developed in the OAR (Office of Aerospace Research) laboratories, US. It consists in studying the behaviour of some of the earth's crust materials under conditions of pressurestrain and temperature similar to those produced by natural or man-made shocks. In the OAR laboratories a high-pressure, high-temperature shear press is being used to duplicate conditions found 18 to 93 miles beneath the surface of the earth.

The shear press, employing a 300-ton hydraulic jack and a 5 kW frequency induction heater, produces pressure of over 750,000 lb./sq. in. and temperatures of 1830° F. In addition, strain rates of from 10 cycles per hour to as little as 0.01 c./hr. can be introduced, thus producing a variance in strain rates similar to the stresses materials at great depths would be subjected to during earth tremors resulting from natural and man-made causes.

The effects of seismic waves on various minerals commonly found in the earth's lower crust are being studied. The first studies are being made with olivine, the most abundant material in the lower crust, to be followed by diopside and zircon.

During the study, wafer-shaped samples of the minerals will be squeezed and heated just as if they were 40 miles beneath the surface. The samples will then be examined for any evidence of structural changes and chemical recombinations.—(J. Frank. Inst., 1963, 276, 573.)

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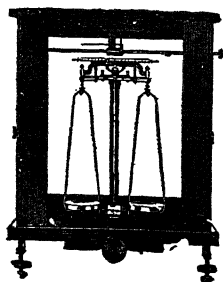
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# SOME ASPECTS OF ROOT NODULATION IN TROPICAL LEGUMES

N. RAJAGOPALAN AND T. S. SADASIVAN

University Botany Laboratory, Madras-5

**A**MONG plant tissues, root nodules of legumes have two unique features: they fix atmospheric nitrogen and contain haemoglobin. Despite comprehensive study of this symbiosis and the resultant specific protein synthesis *in vivo*, the problem has not lost its fundamental interest. In this paper, recent work on root nodules carried out here is presented in the light of foregoing knowledge on the subject.

## SPECIFICITY OF THE ASSOCIATION BETWEEN RHIZOBIA AND LEGUMES

Depending on collections of legume species that could exchange rhizobia with each other, rhizobia are classified into six cross-inoculation groups, viz., *Rhizobium leguminosarum* (*Pisum*, *Vicia*, *Lens*), *Rh. phaseoli* (*Phaseolus*), *Rh. trifolii* (*Trifolium*), *Rh. meliloti* (*Melilotus*, *Medicago*, *Trigonella*), *Rh. lupini* (*Lupinus*, *Ornithopus*) and *Rh. japonicum* (*Soya*). While temperate rhizobia exhibit this specialization in infective kinships to particular plant hosts, the vast majority of tropical legumes belong to the so-called cow-pea cross-inoculation group in which infective promiscuity appears to be very common. Thus, a *Rhizobium* strain from groundnut which belongs to the cow-pea group was shown in this laboratory<sup>1</sup> to induce effective nodulation in *Arachis hypogaea* L., *Phaseolus mungo* L., *Clitoria ternatea* L., *Centrosema pubescens* Benth., *Vigna catjang* Walp., *Psophocarpus tetragonolobus* DC., *P. palustris* DC., *Cyamopsis tetragonoloba* (L.) Taub., *Cajanus cajan* L. Millsp., *Dolichos lablab* L., *Dolichos biflorus* L., *Gliricidia macrocarpa* H.B. et K. and *Crotalaria juncea* L.—representatives of the tribes Gensiteæ, Galegeæ, Hedysareæ and Phaseoleæ of the subfamily Papilionatæ. While cross-inoculation specificity has been based on the economically important and intensively studied temperate species, study of the remaining 90% of the legume genera which still have to be examined in respect of nodulation<sup>2</sup> might confirm or contradict the observations of Wilson<sup>3</sup> who claimed "more than five hundred reasons for abandoning the cross-inoculation groups".

Allen and Allen<sup>4</sup> found *Rh. japonicum* from soybean to produce a few moderately effective nodules on *Arachis hypogaea* which belongs to the cow-pea group. In this laboratory (Gopala-

krishnan and Raju, unpublished), inoculating with three effective strains of *Rh. trifolii*, four of *Rh. leguminosarum* and one from lucerne failed to induce nodulation in the same host. With *Rh. leguminosarum* a few diminutive ineffective nodules developed on *Crotalaria. Lathyrus sativus* L. which belongs to the Pea and Vetch group of *Rh. leguminosarum* did not, however, nodulate with an effective strain from *A. hypogaea*. While reasons for these are not clear, studies on infective relationships between rhizobia and legumes have to await further investigation of the "big cow-pea group (*Vigna*) which has always been somewhat of a problem child of *Rhizobium* classification"<sup>5</sup> Bowen and Kennedy<sup>6</sup> suggest the possibility of establishing effectiveness sub-groups in tropical legumes.

## THE EFFECT OF SOIL TYPE AND SOIL REACTION ON NODULATION

In temperate countries it is well known that extremes of soil reaction could adversely affect nodulation. The importance of this factor does not seem to have been studied widely in the tropics. Inoculation experiments in this laboratory with effective rhizobia was observed to lead to different responses in nodulation of groundnut in red and black soils—two of the major soil types in South India. An effective strain (R4) induced heavy nodulation in *A. hypogaea* in red soils which are acid to neutral (pH 5.5–7.0) more than in black soils which are distinctly alkaline (pH 8.2–10.5) albeit the fact that red soils contain less exchangeable cations than black soils. In sterile cultures pH levels of 4.0, 5.0 and 6.0 were found suitable for plant growth, optimum nitrogen fixation and haemoglobin formation with a most favourable effect at pH 5.0 while fixation deteriorated toward pH 3.0, 7.0 and 8.0 (Fig. 1). This agrees well with the observations of Norris<sup>7</sup> that there is no justification for assuming that tropical legumes need lime because the soil is acid, for they are capable of living and thriving quite normally in distinctly acid soils.

## THE LEGUME-RHIZOSPHERE EFFECT

The role of plant root excretions on the microbial composition of rhizosphere is well defined.<sup>8,9</sup> Thus, Timonin<sup>10</sup> found 275 millions of bacteria

per gram of rhizosphere soil around wheat roots against 21 millions in control soil. The numbers for lucerne were 287 and 22.8 millions respectively, the ratio of rhizosphere to soil in both plants being 12:9.

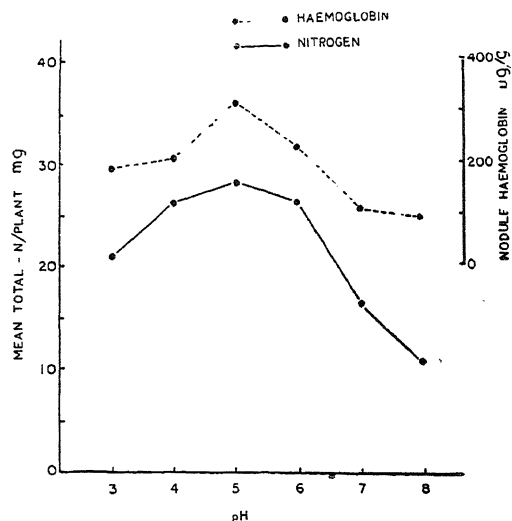


FIG. 1. The influence of soil reaction on nitrogen fixation and haemoglobin content in *Arachis hypogaea*.

However, the legume rhizosphere might stimulate the nitrifying group of bacteria. Thus, at 20 days from germination in *Dolichos lablab* nitrifying group bacteria reach 240 millions per gram of rhizosphere soil from an initial 43 millions at five days. Foliar sprays of sucrose or urea further increased their numbers, while those with thiouracil and gibberellin had an adverse effect.<sup>11</sup> Similarly, nitrifiers which comprised 2% in control soil increased to 12.3% in the rhizosphere soil of *Phaseolus mungo*, while applications of farmyard and green manure changed the percentage of nitrifiers in the rhizosphere to 10.0 and 15.0 in the two treatments. Ammonium sulphate further increased their numbers from 5.0% in the control soil to 48.0 and 43.0% in rhizosphere soil of *Phaseolus* and *Vigna*.<sup>12</sup>

There does not seem to be specific evidence in literature in favour of the rhizosphere effect on rhizobia. While Starkey<sup>13</sup> claimed that rhizobia thrive particularly in contact with legume roots, they have since been reported to occur around the roots of Polygonaceae, Gramineae and Malvaceae.<sup>14</sup> Besides, nodule number in legumes may not bear a relation to either the number of rhizobia in the rhizosphere or to the size of the inoculum<sup>15</sup> although rhizobia may thrive in response to soil amelioration.<sup>16</sup> In

fact, the number of rhizobia present in the rhizosphere of clover and alfalfa ( $10^6$ - $10^9$  organisms per ml. of medium at the time of initial nodulation) have been shown to greatly exceed that required for maximum nodulation.<sup>17</sup>

The role of aspergilli in the rhizosphere of legumes in acid sands where the microbial production of organic acids helps acid-tolerant lupines and seradellas to thrive and enable lucerne and clover to overcome the influence of humic acid was recently emphasized.<sup>18</sup> The predominance of aspergilli in the rhizosphere of groundnut plants<sup>19</sup> grown in lateritic soils is of interest since organic acids such as oxalic, gluconic and citric acids produced by this fungus might increase the availability of soil phosphates under certain conditions.

#### THE EFFECT OF PLANT EXUDATES

Among organic substances exuded from plant roots, organic acids, sugars, amino-acids, reducing compounds, growth factors, exo-enzymes and nucleic acid derivatives are well known.

Preston *et al.*<sup>20</sup> have shown that the growth regulator  $\alpha$ -methoxy phenylacetic acid, when applied to bean hypocotyls moves into the roots, is secreted by the roots into the medium, taken up by the roots of many plants and transmitted to their leaves. Elkan<sup>21</sup> found nutritionally different groups of microbes and higher numbers of rhizobia in the rhizosphere population of a normally nodulating (NN) soybean when compared to that of a near isogenic non-nodulating (*nn*) soybean strain. Since root excretions of this mutant (*nn*) resulted in highly significant decreases in nodulation of the normal plants (NN) Elkan concluded that non-nodulating soybean strains exude nodulation inhibiting principles. Deleuil<sup>22</sup> described that leachates of the roots of perennial species of *Rosmarinus officinalis* and *Erica* prevent the growth of the associated annual legumes in the same soil. Germination and growth of legumes were inhibited when seeds of these were watered with leachates from the toxic Rosmarino-Ericon soil. Root and nodule macerates of the nodulating annual legume species offset this inhibitory effect. Deleuil thus showed that roots and nodules of legumes produce a substance antagonistic to the toxin excreted by the perennial species of the Rosmarino-Ericon association. Again intercropping of cow-peas and *Phaseolus* with grasses cause concern since roots of several Gramineae inhibit the development of bacteria not only in their rhizosphere but in non-rhizosphere as well.<sup>23</sup>

Additions of decomposing plant litter generally promote the growth of amino-acid requiring organisms in the rhizosphere. Similarly, application of decaying organic matter may promote nodulation.<sup>24</sup> However, Garrett<sup>25</sup> points out that toxins from plant litters may predispose plants to greater invasion by root-rot causing organisms. For instance, straw and litter of wheat, barley and rye produce four phenolic inhibitors: *p*-hydroxycinnamic, *p*-hydroxybenzoic, vanillic and ferulic acids, while with rice straw *p*-oxybenzoic and *p*-coumaric, ferulic, caffeic, protocatechuic and salicylic acids are reported.<sup>26</sup> It is, therefore, evident that "many specific and aspecific metabolic accelerators or inhibitors are involved in the interactions between root exudates and rhizosphere microfloras".<sup>27</sup> The study of soil and rhizosphere factors, therefore, becomes essential if legumes are to play their full role in farm management.

#### EFFECTIVE AND INEFFECTIVE RHIZOBIA

Rhizobia may be effective or ineffective depending on their capacity to fix nitrogen during symbiosis. Strainal effectiveness cannot, however, be correlated to their (i) cultural and physiological characteristics, (ii) antigenic structure, (iii) colonial mutation, (iv) phage sensitivity and (v) sensitivity to antibiotic action.<sup>28</sup> Thus, the only criterion, at present, to distinguish between effective and ineffective rhizobia appears to be through careful evaluation of nitrogen fixation in defined host-strain partnerships. Nitrogen fixation depends on both the plant and the rhizobium since the formation of bacteroids—the 'X' and 'Y' forms in which bacteria occur within nodule cells—depends not solely on either bacterium or host but upon a complex interaction between the two entities.<sup>29</sup> Further, effectiveness could be influenced by temperature characteristics, genetic plant factors, host metabolism and its nutrition, for rhizobia could even become pathogenic in the absence of boron.<sup>30</sup>

#### EFFECTIVE AND INEFFECTIVE ROOT NODULES

Hæmoglobin, shown to be a prerequisite for nitrogen fixation, characterizes effective root nodules. Absorption spectra of the pigment obtained with aqueous extracts of nodules after conversion to solutions of pyridine hæmochromogen show sharpened absorption maxima, characteristic of hæmoglobin as detailed in Figs. 2, 3 and 4 for root nodules of *Cajanus*, *Cyamopsis* and *Vigna*. Virtanen<sup>31</sup> found a positive correlation between hæmoglobin content

and the intensity of nitrogen fixation. Bacterial strains are known to differ in their effectiveness depending on their association with particular host species. There are strains which are more effective than the other strains in association with certain plants.<sup>32</sup> Thus as shown in

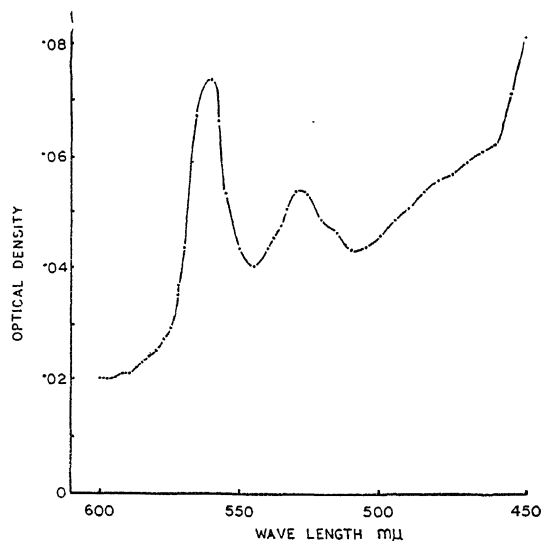


FIG. 2. Absorption spectrum of pyridine hæmochromogen from the root nodules of *Cajanus cajan*.

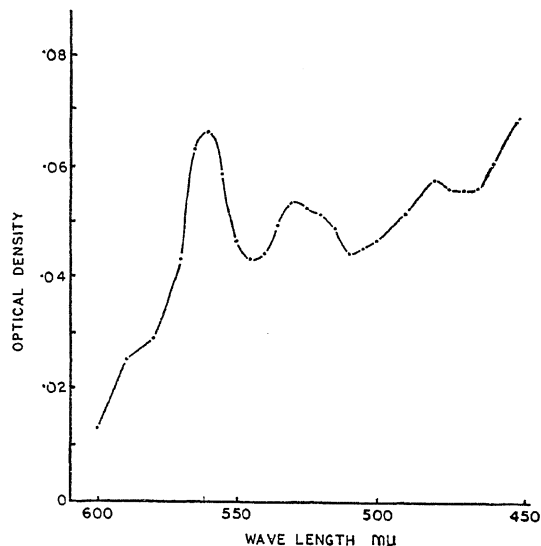


FIG. 3. Absorption spectrum of pyridine hæmochromogen from the root nodules of *Cyamopsis tetra-loba*.

Table I an effective cow-pea strain (R 4) isolated from *Arachis hypogaea* which produced 245 µg. hæmoglobin/g. fresh nodules in *A. hypogaea*, produced as much as 600 µg./g. pigment in association with *Crotalaria juncea*. In comparison,

strains S1, S5, S6 and S7 isolated from *Crotalaria* were only moderately effective (Rajagopalan and Raju, unpublished).

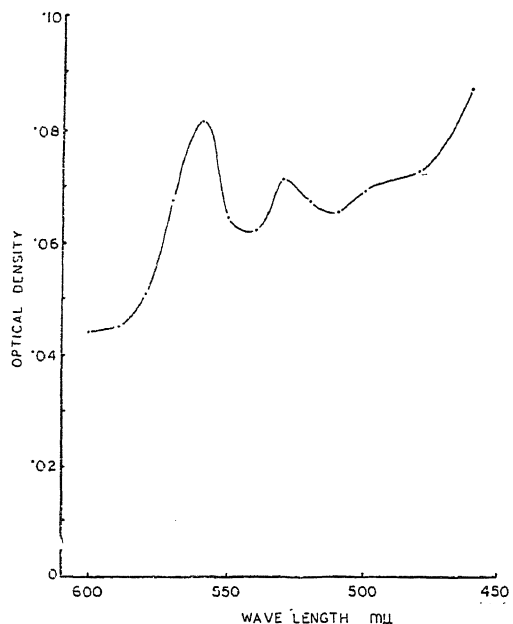


FIG. 4. Absorption spectrum of pyridine haemochromogen from the root nodules of *Vigna catjang*.

TABLE I

Haemoglobin content of nodules produced by various cow-pea rhizobia strains

<i>Arachis hypogaea</i>		<i>Crotalaria juncea</i>	
Strains	Haemoglobin μg./g.	Strains	Haemoglobin μg./g.
R 1	245	S 1	250
R 2	200	S 5	275
R 3	145	S 6	250
R 4	245	S 7	250
R 5	190	R 4	600

Nodules formed by ineffective strains do not contain haemoglobin. Effective nodules in which bacteroid formation accompanies the appearance of the pigment lose their nitrogen fixing ability when it turns green,<sup>33</sup> although as stated by Thornton<sup>34</sup> caution should be exercised in such study, for disintegration of bacteroid tissue equally characterises ineffective nodules, old nodules and those kept in the dark.

While the maxima of root nodule haemoglobin are normally reached just prior to the time of flowering, this may be a function of the age of the plant and condition of its growth. Thus, in *Arachis hypogaea* varieties TMV 2 and TMV 3 grown in unsterile soil under conditions of

TABLE II

The concentration of haemoglobin in the root nodules of *Arachis hypogaea* varieties

Variety	Root nodule haemoglobin μg./g. fresh nodules Days from sowing					
	20	25	35	48	60	70
TMV 2 ..	130	230	260	295	235	225
TMV 3 ..	117	244	295	340	300	220
TMV 5 ..	111	215	285	320	340	180
HG 1 ..	140	159	284	315	330	275

nodulation by endemic rhizobia, the maximal haemoglobin content of nodules are observed between 45 and 50 days; in varieties TMV 5 and HG 1 these maxima are reached at 60 days from sowing.<sup>1</sup> In these varieties, flowering starts from about 22 days after sowing.

The transformation of the red to the green pigment, which is known to result in the onset of conditions leading to cessation of N<sub>2</sub> fixation, does not seem to occur until 53 days in *Arachis hypogaea* (Fig. 5). As seen in the figure,

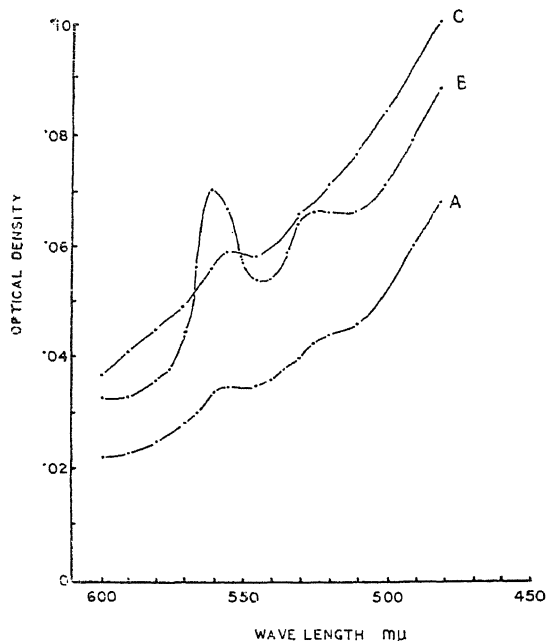


FIG. 5. Absorption spectra of pyridine extractions of root nodules of *Arachis hypogaea*. Curve A: White nodules, 22 days old. Curve B: Red nodules, 53 days old. Curve C: Green nodules, 75 days old.

within 75 days from sowing the absorption maxima of the pyridine haemochromogen from *A. hypogaea* nodules fade rapidly with the change of the red into the green pigment, a time at which the fertilized flowers rapidly put

forth their gynophores for subterranean seed-setting. Further, in this species in which the flowering is extended over a considerable period,<sup>35</sup> the maxima in haemoglobin content are found much later during the flowering period.

#### HAEMOGLOBIN CONTENT OF ROOT NODULES

Thornton<sup>36</sup> and Chen and Thornton<sup>37</sup> showed in a study of effective and ineffective temperate nodules that the amount of nitrogen fixed was a function of the central nodule tissue and it is now known that the central tissue of effective nodules contains haemoglobin along with the bacterial component. The haemoglobin content of nodules was used as an index of effectiveness in nitrogen fixation and a variation in nodule haemoglobin content from 105 µg. to 1,130 µg./g. fresh nodules has been described for peas, bean, alfalfa, vetch and clover. In tropical legumes wide variations are known in the effectiveness of nodules. Of the papilionaceous genera examined in this laboratory, species of *Arachis*, *Phaseolus*, *Clitoria*, *Centrosema*, *Vigna*, *Psophocarpus*, *Cyamopsis*, *Cajanus*, *Dolichos*, *Gliricidia* and *Crotalaria* possessed effective nitrogen fixing root nodules. On inoculation with an effective *Rhizobium* the nodule weight per plant ranged from 1.5 to 3.0 g. in *Arachis* to 20.0-25.0 g. in species of *Psophocarpus*. Their haemoglobin content varied from 240 µg. to 835 µg./g. fresh nodule tissue. On the basis of their haemoglobin content (1.707-66.205 µg. per nodule) these papilionaceous genera possessed effective root nodules.

The haemoglobin content in species of *Dolichos* (780 µg./g. fresh nodules), *Gliricidia* (835 µg./g.), *Psophocarpus* (433 µg./g.) and *Centrosema* (395 µg./g.) indicate very effective symbioses as these were far in excess of that required for effectiveness.

#### FREE AMINO-ACIDS AND AMIDES IN ROOT NODULES

Since free amino-acids constitute the primary products in the assimilation of nitrogen in root nodules, study of their relative occurrence in different legumes may serve to define degrees of effectiveness.<sup>38</sup> An examination of the protein-free extracts of root nodules in this laboratory has shown that variations occur in free amino-acid and amide composition in different genera growing in symbiotic association with an effective strain. This may be construed in terms of host metabolism influencing symbiotic efficiency. In general, asparagine and glutamine amides preponderated in the soluble nitrogen of many nodules as shown in Table III.

TABLE III

Variation in the amide-nitrogen of root nodules of legumes expressed as percentage of the total soluble nitrogen

Legume	Amide-N
<i>Phaseolus mungo</i>	9.9
<i>Vigna catjang</i>	21.0
<i>Clitoria ternatea</i>	21.5
<i>Dolichos biflorus</i>	20.0
<i>Dolichos lablab</i>	34.3
<i>Psophocarpus tetragonoloba</i>	34.5
<i>Arachis hypogaea</i>	44.0
<i>Gliricidia macrocarpa</i>	56.2
<i>Centrosema pubescens</i>	76.4
<i>Cyamopsis tetragonoloba</i>	88.8

While in *Cyamopsis* asparagine dominated the soluble nitrogen fraction (75%), in *Centrosema* both glutamine and asparagine were present in large quantities. Glutamine was present in all legume nodules in varying amounts; on the other hand, asparagine was not detected in some of them. The amides which constituted 44-88% of the soluble nitrogen of nodules in *Arachis*, *Gliricidia*, *Centrosema* and *Cyamopsis* are suggestive of high fixation levels in these species.

Next to the amides, glycine, alanine, leucine, α-aminobutyric and γ-aminobutyric acid were prominent in many nodules. Aspartic and glutamic acid (γ-methylene glutamic acid in *Arachis*) and arginine, ornithine and cystine occurred in progressively lesser quantities. Of the hydroxy acids, serine occurred in quantities comparable to those of glutamic acid in *Phaseolus*. Pípecolic acid was characteristic of this plant. In the nodules of *Trifolium repens* γ-aminobutyric acid was reported<sup>39</sup> but in genera examined here, only small quantities of this amino-acid were detected. β-alanine, a decarboxylation product in Leguminosae, occurred in large quantities in *Dolichos* and *Vigna*, with less amounts in *Cyamopsis*. Arginine occurred in larger quantity in nodules of *Arachis* than in others, while phenylalanine, tryptophane and tyrosine were not observed in most, with the probable exception of *Dolichos*.

The preponderance of amides in the soluble nitrogen of nodules in the tropical species mentioned here indicate effectiveness of their symbiosis which their high haemoglobin content further serves to emphasize.

#### THE PRACTICAL ASPECTS OF LEGUME NODULATION TO TROPICAL AGRICULTURE

The quantity of nitrogen fixed by a legume per acre depends on the nodule number, their size, longevity, the bacterial strain, condition of

plant growth and crop management. While fixation-benefit depends on the nodule volume per acre of crop, very few field observations have so far been made in the tropics. Crops in Britain have been shown to have higher nodule weight per plant than tropical crops which may possibly be due to higher soil moisture and lower temperature. Thus, Russell<sup>40</sup> considered that in species of *Vicia*, *Phaseolus*, *Arachis*, *Glycine* and *Vigna* which may have between 100 and 1,000 nodules, the individual nodule weight may vary between 1 and 40 mg. In many cultivated legumes grown in association with an effective cow-pea strain in this laboratory, this weight ranged from 4.5-225.0 mg. per nodule which showed that some Indian crop plants have, on an average, greater weight per nodule than was previously known. Their haemoglobin contents (1.707 to 66.205  $\mu$ g. per nodule and 240 to 335  $\mu$ g./g. fresh nodules) clearly indicate effective symbiosis. However, far too little is known about tropical crops to make any generalization. The statement that legumes carry nodules on their roots and that they benefit the soil is only doubtfully true for many large-seeded cultivated crops such as pigeon-pea, bean, groundnut, sunnhemp, green-, black- and horse-gram. This is so because if they carry nodules, which is not often so under good farming conditions, most nitrogen fixed is removed from the land in the seed crop while nearly all the rest goes with vines or straw at harvest. Russell<sup>40</sup> points out that in the tropics "many legumes grown for the ostensible purpose of raising the soil nitrogen level are not even nodulated for most of their growing season". Whether this lack of nodulation applies only to genera or entire subfamilies remains unknown. Undoubtedly the problem of root nodule nitrogen fixation requires reinvestigation in the tropics.

We thank Drs. L. Saraswathi-Devi and C. B. Sulochana for critically reading the manuscript.

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A RARE HAPLOID CELL IN A ROOT OF *ALLIUM CEPA*

SARASWATHY ROYAN-SUBRAMANIAM\*

Cytogenetics Laboratory, Department of Biochemistry, Indian Institute of Science, Bangalore-12

THE interest in "somatic reduction" and its implications stimulated by Huskins<sup>1</sup> led to an extensive series of investigations.<sup>2</sup> While the occurrence of cells, tissues, roots or even entire seedlings with reduced chromosome numbers is not uncommon in polyploids,<sup>3-7</sup> the phenomenon is considered to be extremely rare in diploids. A "reductional grouping" giving rise finally to a cell with a reduced chromosome number is considered to be rather a rare event in normal roots of *Allium cepa*.<sup>8</sup> The probability of such an origin of a haploid cell with a complete genome is considered to be less than  $10^{-6}$ .

Naturally, records of somatic reduction in normal roots of *A. cepa* are rather few.<sup>9</sup> Two prophase nuclei with 7 chromosomes each were observed by Srinivasachar.<sup>10</sup> The occurrence of a cell with a "reductional grouping" and another with only a haploid complement of chromosomes in a root is, therefore, of unusual interest. These rare examples were observed during a survey of the factors to be controlled for revealing the structural details of the chromosomes in material fixed in acetic alcohol.<sup>11</sup>

In view of the possibility that these rare phenomena may be repeated, the succeeding crops of roots from the same bulb were scanned. It was during such an exploration that cells with two nuclei, two metaphases and tetrasomatic complements of chromosomes were observed. The procedure was to clip the root tips for processing as hæmatoxylin squashes<sup>11</sup> and then return the bulb to the moist sand kept in an incubator at 30° C. Table I summarizes the results obtained.

The segregation of metaphase chromosomes into groups of eight each were observed in one of the roots of the first lot. Figures 1 and 2 taken under phase contrast and ordinary illumination respectively illustrate their orientation in the cell. It is difficult to judge whether they are constituted by the segregated homologues.<sup>1,12</sup>

A metaphase showing eight chromosomes alone in another cell of the same root (Figs. 3 and 4) is suggestive of its possible origin from a reductional grouping. The boundaries of these cells are incomplete. While this fact militates against their acceptance as critical proof for the rare occurrence of "somatic reduction" and haploid cells in normal material, independent confirmation was available in the form of a rare metaphase with 8 diplo-chromosomes in colchicine-treated material.<sup>13</sup>

When reductional groupings occur in normal material, they have to be considered as the result of spindle abnormalities. These appear to be accentuated by chemicals.<sup>9,14,15</sup> Srinivasachar and Patau<sup>8</sup> remark that one of the mechanisms by which reductional groupings could give rise to a haploid cell may be by a spindle which "even if somewhat disorganized, still functions so that sister chromatids move towards opposite poles" (p. 235).

Rare spindle abnormalities in normal roots of the same bulb could be in different directions as evidenced by the discovery of cells with two nuclei, two metaphases and tetrasomatic anaphases (Table I). Figure 5 shows a bi-nucleate cell and Fig. 6, one with two metaphases.

TABLE I

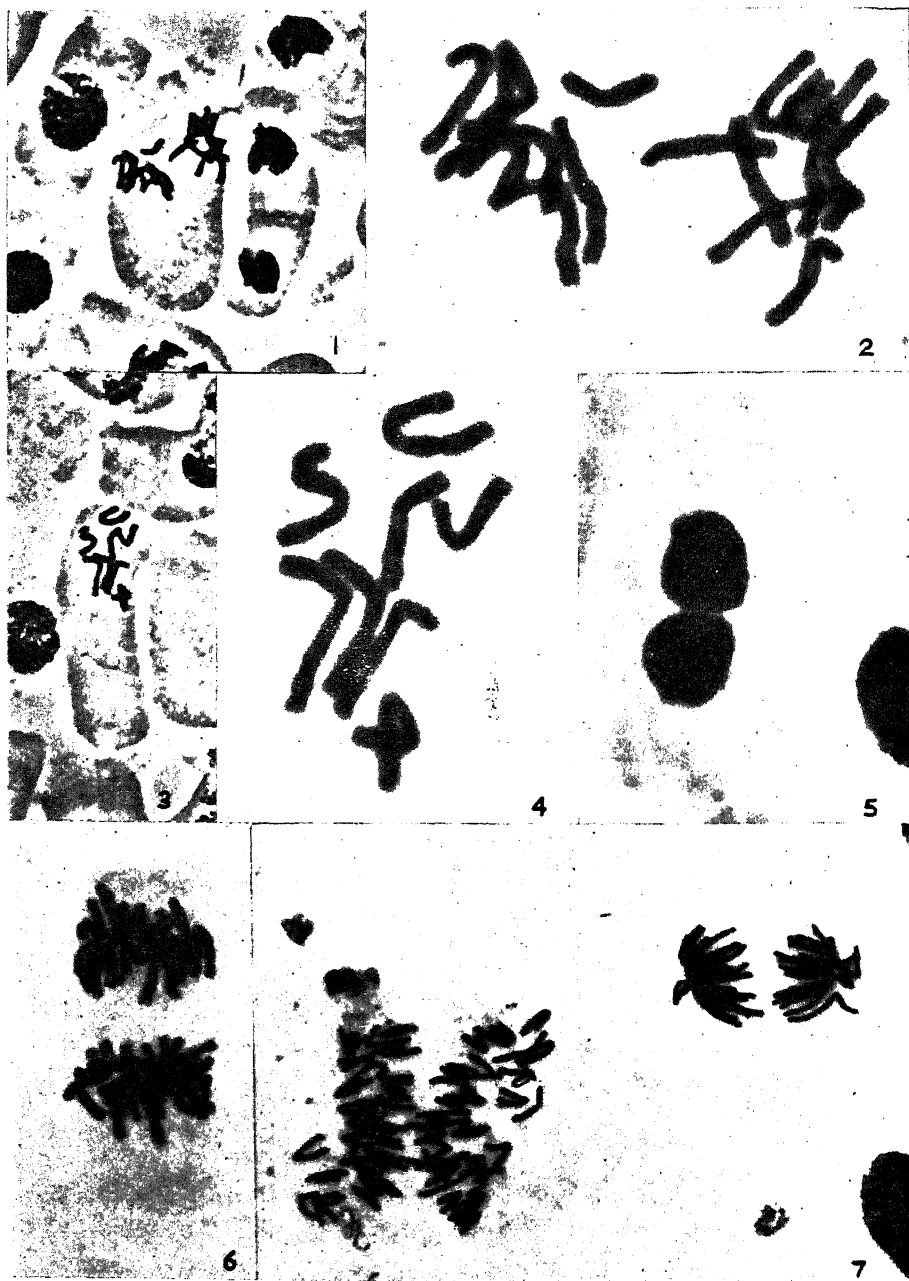
Lot No.	After germination for (days)	No. of root-tips collected	Remarks
1	2	20	Two instances of tetrasomy in one root. A reductional grouping and a haploid cell in another root.
2	4	4 Treated with <i>p</i> -dichlorobenzene for 105 min.	Normal.
3	7	3	Two metaphases in one cell.
4	13	Main 5 Side 6	A binucleate cell and sectors of tetrasomatic cells. Normal.
5	15	Main 1 Side 2	Cells normal. Favourable for study of chromonemata.
6	18	Main 6	Two cells with 4x complement.

\* Scientists' Pool of C.S.I.R.

Diploid and tetrasomatic anaphases lying side by side are illustrated in Fig. 7.

The occurrence of cells with a viable haploid chromosome complement is an event whose rate of incidence is suspected to be smaller than

even that of gene mutations.<sup>8</sup> The presence of cells with two nuclei, two metaphases and tetrasomatic anaphases in roots of the same bulb in which a haploid genome was observed in one of the cells, is suggestive of spindle



FIGS. 1-7. Figs. 1-2. Metaphase. Chromosomes segregated into two groups of 8 each. Figs. 3-4. Metaphase with 8 chromosomes. Fig. 5. Bi-nucleate cell. Fig. 6. Two metaphases in a cell. Fig. 7. Diploid and tetrasomatic anaphases. Figs. 1 and 3. Phase Contrast,  $\times$  ca. 400. Figs. 2, 4-7. Ordinary illumination. Figs. 2 and 4,  $\times$  ca. 1,500. Figs. 5 and 6,  $\times$  ca. 800. Fig. 7,  $\times$  ca. 600.

abnormalities in different directions and as such the origin of a haploid cell with 8 chromosomes should be a random phenomenon.

Grateful acknowledgment is made to the Council of Scientific and Industrial Research, New Delhi, and the Indian Institute of Science, Bangalore, for their encouragement.

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## THE SPECIES ANCESTRAL TO CULTIVATED RICE

S. SAMPATH

Central Rice Research Institute, Cuttack-6

**T**RACING the origin of cultivated rice from its wild progenitors is both interesting and important. Two recent publications, by Richharia<sup>1</sup> and by Kihara,<sup>2</sup> have gone critically into the botanical aspect of this subject. It is generally agreed that the cultivated rice, *Oryza sativa*, originated in Asia and that the common wild rices of India are its closest relatives. Some unexpected difficulties have however arisen in giving the correct specific names to these wild rices, and it is here intended to explain the difficulties and also to offer a solution.

Both Richharia<sup>1</sup> and Kihara<sup>2</sup> use the specific name *Oryza perennis* Moench for a primitive species which is closely related to cultivated rice and is widely distributed in Africa and Asia. The nomenclature by Moench was based on plants grown in the botanic garden in Marburg, the seeds of which had been collected from Cuba. The type specimen has been lost and the description is vague and inadequate to determine the taxon to which the name applies. Tateoka,<sup>3</sup> after a critical examination of the relevant publications and enquiry, concludes that application of this specific name is uncertain, the type specimen could have been a variety of *O. sativa*, could have been *O. latifolia* or the long-anthered diploid primitive species for which this name was later widely used. It is held that this matter cannot be solved by reference to authorities and that a fresh decision has to be made.

The solution offered is based on two premisses. The first (A) is that clear taxonomic distinction

should be made between a species evolved in nature, and a cultigen evolved by man for his needs. The taxonomy of cultigen is always complex and may rarely coincide with that of natural species. For example, at the Central Rice Research Institute novel genotypes artificially produced and grown, include selections derived from hybrids between African and Asian species, chromosome variants of *O. sativa*, tetraploids derived from interspecific hybrids, and a *Spontanea* rice with liguleless leaves. These would not morphologically or genetically correspond to a single well-defined species. Parallel situation is found in other cultigens. For convenience and utility, cultigens should be considered as distinct taxa. The second premiss (B) is that taxonomy should serve a purpose, and in this instance should embody the findings of cytogenetical research and should also be acceptable to rice botanists in different parts of the world. In this connection it may be recorded that at a Symposium on rice genetics and cytogenetics, held in Los Banos, Philippines, in February 1963, the participants expressed their preference for retaining the specific name *O. perennis* for the species from which *O. sativa* was evolved.

From the first premiss it is held that the ancestral species should not be considered as a variety of the cultivated species and therefore the name of *O. sativa* var. *Fatua* Prain should not be given to the taxon concerned. The name was given to wild rices occurring as weeds, and did not take into consideration the nomen *O. rufipogon* described by Griffith earlier.

Tateoka<sup>3</sup> has used the name *O. rufipogon* Griffith for the common wild rices of India and South-East Asia in his revision of the genus. It is now intended to "split" the wild rice assemblage into two species, retaining *O. rufipogon* for one group. The reasons for this "split" are as follows:

Work at the Central Rice Research Institute has shown that the annual wild rice of Asia, occurring as weeds in rice fields and adjacent ditches, is a hybrid species evolved by natural crossing between *O. sativa* and its ancestral species. The evidence for this interpretation is enumerated below.

1. Natural crossing between *O. sativa* and a perennial species is taking place seasonally, in favourable localities.

2. The segregants from parallel artificial crosses resemble the weed population.

3. Some of the weed rice population show semisterility, and when grown experimentally segregate for plants resembling local cultivated varieties.

4. Hybridising *O. glaberrima* of Africa with Asian perennial rice also results in such weed-like segregants, and other Afrasian and Amerasian combinations give similar results.

The cytogenetic analysis of the weed population and the artificially produced genotypes are being carried out at Cuttack as well as elsewhere and the hypothesis of hybrid origin of annual weeds or *Spontanea* rices is strongly supported. These *Spontaneas* are wide-spread, occurring in a broad belt from Queensland, Australia to Volga delta in U.S.S.R. constituting an enormous population of different genotypes. It is not proved and it cannot be proved that all the *Spontaneas* are of hybrid origin; some of them are hybrids of recent origin, while others are probably segregants from more ancient hybrids.

Since a cultigen, *O. sativa*, has probably contributed to the origin of *Spontaneas*, it is desirable that the latter be distinguished taxonomically from a natural species (Premiss A). The specific name *O. rufipogon* can apply either to the perennial species which is one parent, or to *Spontaneas* which are descendants, but not to both. The description of Griffith<sup>4</sup> does not make clear, to which taxon he is referring and he does not seem to be aware that there are two taxa involved. Watt<sup>5</sup> who had made wider collection of wild rices of India, and had compared them critically, recognises four groups, of which var. 1, *rufipogon*, and var. 3, *bengalensis*, are two. The first is identified by Watt as

corresponding to Griffith's taxon, and the other corresponds to the natural ancestral species. This grouping is accepted and *O. sativa* var. *bengalensis* Watt is here described as *O. perennis* Moench, emend. Sampath. in accordance with premisses A and B. The living collection at the Institute indicates that both the species are differentiated into subspecies in different regions. The taxonomy of the subspecies is postponed till cytogenetic studies are extended. Because the two species, *O. perennis* and *O. rufipogon*, are sympatric and cross-fertile, well-defined morphological distinctions are difficult to establish. Variability in populations of *O. rufipogon* is considerable. The two species can be differentiated by selecting the extreme classes, or by taking into account a group of characters. The habitat of *O. perennis* in ponds and ditches where there is water depth of 10 to 50 cm. The plants are potentially perennial and form a short tuft in dry season. Creeping stems and short rhizomes are formed in this season. During the monsoon season, the tillers float and can branch as well as root at nodes. The buds grow at an angle from the stem and pierce the leaf-sheath on emergence. The panicle is fully exerted, open and the spikelets are slender rarely exceeding 3 mm. in width and the awns are also slender. *O. rufipogon* has wider distribution, being prevalent in upland rice fields, and is seasonal, being seed propagated. The tillering is often semi-erect or erect, and buds emerge parallel to the internode and rarely pierce the sheath. The panicles are sometimes partly exerted, and often compact. The grains are coarser (mostly exceeding 3 mm. in width) as also the awns. The presence of genes from *O. sativa* is the probable cause of increased grain size. The key to the species can best be based on anther length in comparison with spikelet length.

#### KEY

Ligule of middle leaves 15 to 30 mm. long, rarely longer, always acute: 3 species. Other species of the genus *Oryza* have generally shorter ligules which are not acute.

1. Spikelets persistent . . . *O. sativa*
2. Spikelets deciduous (shattering):
  - A. Anthers 4 mm. long or longer, filling the spikelets close to apex . . . *O. perennis*
  - B. Anthers 3 mm. long, varying from 2.5 to 3.5 mm. leaving a distinct gap at the apex of spikelet . . . *O. rufipogon*

The species *O. perennis* is widely distributed in Asia having been collected from Orissa, Bengal, Assam, Manipur, Burma, Thailand and Philippine Islands. The strongly rhizomatous and erect-growing species of Africa listed as *O. perennis* Moench subspecies *Barthii* A. Cheval. is closely related to this species. A taxon occurring in Cuba, intermediate between African and Asian groups referred to as *O. perennis* Moench (Syn. *O. cubensis* Ekman) in some publications, is also considered to belong to this species. The description is based on material collected in Orissa.

*Oryza perennis* MOENCH, EMEND. SAMPATH.

Gramen in vadis ad 70 cm. altis crescit, superstes vero est tempore sicco per fasciculos, rhizomatibus repentibus. Culmi in aqua flexi ad nodos ramiferos, radiculis vero ornati ad nodos inferiores. Folii vagina longa, tumescens atque culmos natautes supportans. Ligula membranacea ca. 20 mm. longa acuta, ad apicem

bifida. Panicula penitus exserta, patens, spiculis 100-130 ornata pedicello oblique fixis. Lemmata sterilia lineari-lanceolata, ad margines trichomatibus minutis ornata. Spiculæ ca. 8.5 mm. longæ et 3 mm. latæ, apiculo purpureo ornatae. Antheræ ca. 5.5 mm. longæ. Arista gracilis, scabra, partim pallide purpurea, ca. 74 mm. longa.

Neotypus, Sampa. No. 12. C.R.R.I. lectus in cisterna Kanori dicta ad Cuttack, in ditone Orissa, in India, et positus in Herbario Nationali Centrali ad Calcuttam (CAL).

Thanks are due to Dr. R. H. Richharia, Director, for facilitating this study, and to Rev. Fr. Santapau for assisting in preparation of this paper.

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# CARNEGIE INSTITUTION OF WASHINGTON YEAR-BOOK NO. 62\*

THE issue of the previous Year-Book (61) marked the Sixtieth Anniversary of the Carnegie Institution of Washington. In 1902 Andrew Carnegie bequeathed a sum of ten million dollars "to found in the city of Washington an Institution which shall in the broadest and most liberal manner encourage investigation, research, and discovery". Ever since its establishment the Carnegie Institution of Washington has been promoting original research "by systematically sustaining projects of broad scope that lead to the discovery and utilization of new forces for the benefit of man", and with its expanding activities and collaboration with other institutions, it stands today as an ideal research centre for "unfettered and uncommitted" research in its broadest aspects. The Year-Books of the Carnegie Institution form significant additions to current scientific literature for they maintain a continuity of approach in the various fields of study undertaken by the seven departments of the Institution besides reporting the latest results achieved in each case during the year under report.

In a brief review as this we have necessarily to make a choice. Three outstanding areas of recent investigation are of particular interest,

namely, astronomy, geophysics and genetics. The work in the Mount Wilson and Palomar Observatories in close collaboration with the Radioastronomy Observatory of the California Institute of Technology has enabled more and more radio-sources to be identified unambiguously with objects observed optically. A major discovery during the year is the identification of the radio-source designated 3C273 with an optically observed galaxy which is 100 times more luminous than galaxies such as the Andromeda, and its rate of radiation estimated at  $10^{46}$  ergs per second is the most powerful known in the universe so far.

The work in the Geophysical Laboratory has been augmented during the year by research groups of visiting investigators representing nine countries. Their fields of research included experimental and statistical petrology, high pressures, ore mineralogy, rock ages, and organo-geochemistry. The research during the year has yielded new evidence to show that mild thermal degradation of kerogen is the principal mechanism by which hydrocarbons in natural gas and petroleum are produced.

The Genetics Research Unit is continuing to concentrate on the biochemical structure of the single chromosome possessed by each bacteriophage particle, so as to gain fundamental knowledge about synapsis, heterozygosis, genetic deletions and such other phenomena whose explanations remain still obscure.

\* Carnegie Institution of Washington Year Book No. 62 (Carnegie Institution, 1520, P Street, Northwest, Washington, D.C. 20005), 1963, pp. xi+54+551, Price \$1.50. (cloth bound).

## LETTERS TO THE EDITOR

OXIDATION OF ALCOHOLS BY  
PEROXYDISULPHATE

STUDIES of oxidation of a wide variety of substances, all in aqueous medium, by peroxydisulphate have been reviewed recently by House.<sup>1</sup> Kinetics of oxidation of isopropanol,<sup>2-4</sup> methanol<sup>5-6</sup> and ethanol<sup>6,7</sup> have been reported. Bawn<sup>7</sup> has also studied oxidation of ethanol by  $S_2O_8 = -Ag^+$  or  $Cu^{++}$  system. There is controversy with regard to general nature of mechanism of oxidation especially of isopropanol, following either free radical or ionic type. We have made a systematic study of oxidation of methanol, ethanol, normal and secondary butanols by peroxydisulphate in aqueous solution in the presence of air as well as under deaerated conditions, in the presence as well as absence of  $Ag^+$  ions. The reaction systems peroxydisulphate-ethanol or methanol have been studied both under buffered (pH = 8 with phosphate) and unbuffered conditions (pH = 2 to 3). The peroxydisulphate-*n* and *sec*-butanol systems have been studied under unbuffered conditions only in view of some complex features appearing with buffers. The uncatalysed reactions have been generally studied at 60°–80° C. and the  $Ag^+$  catalysed reactions at 50°–70° C. All experiments have been conducted at constant ionic strength. The oxidation reactions have been followed by measuring the rate of disappearance of peroxydisulphate by iodometry<sup>8</sup> and the orders for the reactants reported in this note refer to this rate only.

We have observed in the case of all alcohols inhibition periods in the presence of oxygen. In the absence of oxygen the orders with respect to peroxydisulphate and alcohol (both ethanol and methanol) are 3/2 and 1/2 respectively both for buffered and unbuffered conditions. The order with respect to  $Ag^+$  is found to be one-half. It is interesting to compare that Bawn<sup>7</sup> under slightly different experimental conditions (peroxydisulphate-ethanol-diphenylpicrylhydrazyl) has obtained orders with respect to peroxydisulphate and  $Ag^+$ , one and one-half respectively. Hydrogen ions (0.1–1.0 M) do not influence the rate (catalysed or uncatalysed) of oxidation. Increasing the ionic strength (by addition of  $ClO_4^-$  ions and/or  $HSO_4^-$  ions) of the medium decreases the

rate. The stoichiometry for peroxydisulphate-ethanol system is found to be 1:1 by product (acetaldehyde and trace of acetic acid) analysis. The rate constants for uncatalysed peroxydisulphate-methanol system

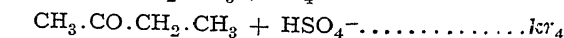
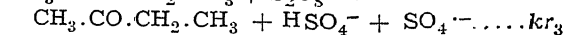
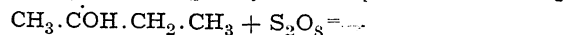
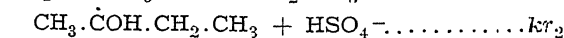
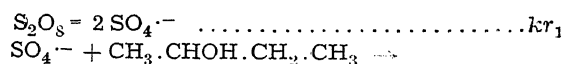
$k_1 = 2.045 \times 10^{-2} = 1.351 \times 10^{11} \exp. (-20,140/R \times 343) \text{ lit. mole}^{-1} \text{ sec}^{-1}$  and for peroxydisulphate-ethanol system

$k_2 = 1.763 \times 10^{-2} = 2.549 \times 10^8 \exp. (-15,250/R \times 328) \text{ lit. mole}^{-1} \text{ sec}^{-1}$  have been obtained. The corresponding rate constants for catalysed reactions respectively are

$k_3 = 2.99 = 3.131 \times 10^{10} \exp. (-15,740/R \times 343) \text{ lit.}^{3/2} \text{ moles}^{-3/2} \text{ sec}^{-1}$  and  $k_4 = 3.71 = 3.129 \times 10^7 \exp. (-10,400/R \times 328 \text{ lit.}^{3/2} \text{ moles}^{-3/2} \text{ sec}^{-1})$ .

Our results generally support the mechanism given by Bartlett *et al.*<sup>5</sup> and Kolthoff *et al.*<sup>6</sup> that the reactions are free radical in nature. Calculation of rate constants,  $Ag^+$  catalysis, effect of  $H^+$ ,  $ClO_4^-$ ,  $HSO_4^-$ , buffer, oxygen, etc., on the rates and evaluation of activation energies, frequency factors, etc., comprise new features in our studies not reported earlier.

In the case of peroxydisulphate-secondary butanol (uncatalysed) reaction, our results with regard to orders of reactants, stoichiometry, product analysis, etc., are in conformity with a mechanism in which the radical ion  $SO_4^{\cdot-}$  acts as an initiator and  $SO_4^{\cdot-}$  as well as  $S_2O_8^=$  ions act as terminators.



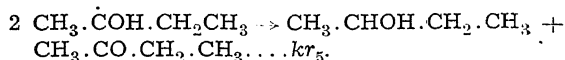
On the basis of this mechanism  $-d[S_2O_8^=]/dt = K_1[S_2O_8^=] [CH_3.CHOH.CH_2.CH_3]^{\frac{1}{2}}$ .  $K_1 = (kr_1 kr_2 kr_3 / kr_4)^{\frac{1}{2}} = 6.195 \times 10^{-3} = 6.637 \times 10^{13} \exp. (-25,170/R \times 343) \text{ lit.}^{\frac{1}{2}} \text{ mole}^{-\frac{1}{2}} \text{ sec}^{-1}$ . The order with respect to  $Ag^+$  is one-half and the orders with respect to peroxydisulphate and alcohol remaining unaffected under catalysed conditions. The corresponding rate constant for the catalysed reaction is

$K_2 = 0.8128 = 14.22 \times 10^{11} \exp. (-17,640/R \times 343) \text{ lit. mole}^{-1} \text{ sec}^{-1}$ . The effect of hydro-

gen ion, bisulphate ion and ionic strength are same as in methanol and ethanol oxidations. Methyl ethyl ketone has been identified as the product.

The rate expression for the peroxydisulphate-*n*-butanol uncatalysed system is  $-d[S_2O_8^{2-}]/dt = K[S_2O_8^{2-}]^{3/2}$  and

$K = kr_3 (kr_1/k_r)^{1/2} = 5.833 \times 10^{-3} = 2.729 \times 10^{15} \exp. (-27,740/R \times 343) \text{ lit.}^{1/2} \text{ mole}^{-1/2} \text{ sec.}^{-1}$   
The 3/2 order for peroxydisulphate and zero order for alcohol may be explained on the basis of the termination step being mutual type in this case:



Further experimental details with a complete discussion will appear elsewhere.

Dept. of Physical Chemistry, L. R. SUBBARAMAN.  
University of Madras, M. SANTAPPA.  
Madras-25, January 31, 1964.

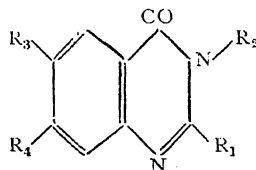
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## CYANOETHYLATION OF QUINAZOLINONES

QUINAZOLINONES, as a class of compounds, have not been so far subjected to cyanoethylation. Recently, we had an opportunity to study the addition of acrylonitrile on 3,4-dihydroquinazolin-4-ones in presence of catalysts like ammonia, aqueous sodium hydroxide and sodium methoxide.

Cyanoethylation proceeds smoothly on 3,4-dihydroquinazolin-4-one in presence of aqueous ammonia or sodium hydroxide solution to yield 3-cyanoethyl-3,4-dihydroquinazolin-4-one. Under similar conditions, 2- and/or ring-substituted quinazolinones do not add on acrylonitrile. 2-Methyl (or ethyl)-3,4-dihydroquinazolin-4-one adds on acrylonitrile in tetrahydrofuran in presence of sodium methoxide as catalyst to yield the corresponding 3-cyanoethyl derivative. The 2-alkyl-6 (or 7) chloroquinazolinones require rather drastic conditions for cyanoethylation; they have been cyanoethylated in position 3 by heating them in sealed tubes at 60–80° with acrylonitrile in tetrahydrofuran and sodium methoxide as catalyst. The sealed-tube reactions are, however, accompanied by sparingly soluble by-products which have not been characterised. In this investigation, all the 3-cyanoethyl derivatives have been hydrolysed to their corresponding acid amides with concentrated sulphuric acid.

(a) 3-Cyanoethyl-3,4-dihydroquinazolin-4-one.  
—To 3,4-dihydroquinazolin-4-one (1 g.) in water (10 ml.) and liquor ammonia (1 ml.) was added acrylonitrile (3 ml.) in the cold. The reaction mixture was stirred and warmed to 50° and



No.*	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	m.p. °C.	Nitrogen %	
						Found	Calculated
1 <sup>a</sup>	H	—CH <sub>2</sub> CH <sub>2</sub> CN	H	H	138–39	20.70	21.11
2 <sup>d</sup>	H	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	H	H	192–93	19.01	19.35
3 <sup>b</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CN	H	H	145	19.78	19.71
4 <sup>d</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	H	H	210–11	18.05	18.18
5 <sup>b</sup>	CH <sub>2</sub> CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CN	H	H	179–80	18.78	18.50
6 <sup>d</sup>	CH <sub>2</sub> CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	H	H	193	17.04	17.14
7 <sup>c</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CN	Cl	H	153–54	16.50	16.96
8 <sup>d</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	Cl	H	209–10	15.82	15.81
9 <sup>c</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CN	H	Cl	175	16.53	16.96
10 <sup>d</sup>	CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	H	Cl	210–11	15.49	15.81
11 <sup>c</sup>	CH <sub>2</sub> CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CN	H	Cl	173–74	16.48	16.06
12 <sup>d</sup>	CH <sub>2</sub> CH <sub>3</sub>	—CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>	H	Cl	189–90	15.19	15.03

\* The superscripts refer to the methods of preparation.

held at that temperature for 30 minutes; it was then allowed to stand at room temperature overnight, when the colourless, alkali-insoluble 3-cyanoethyl-3,4-dihydroquinazolin-4-one (0.7 g.) precipitated out; m.p. 136–38°. It was crystallized from aqueous ethanol as colourless needles melting at 138–39°. Found: N, 20.70; Calc. for  $C_{11}H_9N_3O$ : N, 21.11%. [Use of sodium hydroxide solution (1 ml.; 10%) instead of ammonia in the above reaction gave rise to the same product.]

(b) *2-Ethyl-3-cyanoethyl-3, 4-dihydroquinazolin-4-one*.—To 2-ethyl-3, 4-dihydroquinazolin-4-one (1 g.) in tetrahydrofuran (3 ml.) was added sodium methoxide (0.1 g.) and acrylonitrile (5 ml.) in the cold. The reaction mixture was held at 60–70° for 90 minutes and then allowed to stand at room temperature overnight. The solvent and the excess of acrylonitrile were removed *in vacuo*, and the solid residue was triturated with potassium hydroxide solution (2 g. in 20 ml.); the insoluble solid fraction was crystallized from aqueous ethanol to obtain 2-ethyl-3-cyanoethyl-3, 4-dihydroquinazolin-4-one as colourless needles (0.15 g.) melting at 179–80°. Found: N, 18.78; Calc. for  $C_{13}H_{13}N_3O$ : N, 18.50%.

(c) 2-Methyl-7-chloro-3-cyanoethyl-3, 4-dihydroquinazolin-4-one.—2-Methyl-7-chloro-3, 4-dihydroquinazolin-4-one (1 g.), tetrahydrofuran (3 ml.), sodium methoxide (0.2 g.) and acrylonitrile (30 ml.) were taken in a sealed pyrex tube (30 ml. capacity) and heated at 70° for 4 hours. The yellow reaction product was triturated with sodium hydroxide solution (10% ; 20 ml.) and the residue was crystallized from aqueous ethanol to obtain the title compound melting at 175°. Found: N, 16.53; Calc. for  $C_{12}H_{10}N_3ClO$ : N, 16.96%.

(d) 3-Carbamoylethyl-3, 4-dihydroquinazolin-4-one.—3-Cyanoethyl-3, 4-dihydroquinazolin-4-one (0.5 g.) was dissolved in concentrated sulphuric acid (5 ml.) and held at room temperature for 4 hours. The solution was then poured into crushed ice (15 g.) and the resulting solution was rendered alkaline with liquor ammonia to obtain the title compound as a colourless crystalline solid (0.4 g.). It was crystallized from aqueous ethanol; m.p. 192–93°. Found: N, 19.01; Calc. for  $C_{11}H_{11}N_3O_2$ : N, 19.35%.

Research and Development Division,  
Sarabhai Chemicals,  
Baroda, *January 27, 1964.*

# STUDIES ON THE PRECIPITATION OF CERIUM (IV) AND LANTHANUM WITH MALONIC, SUCCINIC, ADIPIC (AND PHTHALIC) ACIDS

A NUMBER of dicarboxylic acids have previously been studied for the precipitation of rare earths. Oxalic acid has been commonly used as a reagent for the determination of rare earths.<sup>1,2</sup> Vickery<sup>2</sup> and Martini<sup>3</sup> have reported the use of succinic acid for the detection of rare earths. Ryabchikov and Teret'eva<sup>4</sup> found that malonic, succinic and adipic acids form soluble complexes with yttrium group of rare earths and precipitate the cerium group metals, while phthalic acid precipitates both the yttrium and the cerium group elements.

As the above results except in the case of oxalic acid were only of a qualitative character, the present investigations were undertaken to study quantitatively the precipitation of cerium (IV) and lanthanum with malonic, succinic, adipic (and phthalic) acids.

*Procedure for the precipitation of cerium (IV) and lanthanum.*—Excess of the dibasic acid (1 gm.) was added to 100–150 ml. of a solution containing cerium (IV) or lanthanum ions and the pH adjusted with the help of ammonium hydroxide or hydrochloric acid. The solution was heated for about 5 minutes at 100°, cooled to room temperature and filtered through Whatman filter-paper No. 42. The precipitate was washed with an aqueous solution of the dibasic acid adjusted to the pH of the experimental solution. The precipitate was dried and ignited to the oxide at 850°. Tables I-IV and V and VI give the results of the precipitation of cerium (IV) and lanthanum respectively.

TABLE I

CeO <sub>2</sub> taken, mg. oxine method		14.7	
CeO <sub>2</sub> found, mg. using malonic acid	11.5	6.7	No ppt.
pH	2.0	2.8	3.5-7.0

TABLE II

CeO <sub>2</sub> taken, mg. oxine method	14.7					6.8				
CeO <sub>2</sub> found, 12.8 12.8 12.8 mg. using succinic acid.				5.4	5.8	6.0	6.0	6.0	6.1	
pH	2.4	3.4	4.0	4.5	5.0	5.5	6.0	6.5	7.0	



TABLE III

CeO <sub>2</sub> taken, mg. oxine method	14.7				6.8		
CeO <sub>2</sub> taken, mg. 13.4 13.6 13.8 14.2 using adipic acid					6.6	6.4	6.6
pH	3.0	4.0	5.0	5.5	6.0	7.0	7.4

TABLE IV

CeO <sub>2</sub> taken, mg. oxine method	14.7							
CeO <sub>2</sub> found, mg. 12.4 12.6 12.8 13.0 13.6 13.6 12.8 using phthalic acid								
pH	1.7	2.2	2.7	3.2	3.6	4.0	4.5	
CeO <sub>2</sub> taken, mg. oxine method	6.8							
CeO <sub>2</sub> found, mg. using phthalic acid	6.0		6.2		6.6			
pH	5.0		6.0		7.0			

TABLE V

La <sub>2</sub> O <sub>3</sub> taken, mg. oxine method	20.4					
La <sub>2</sub> O <sub>3</sub> found, mg. using succinic acid	3.0	10.0	12.4	9.4	9.0	
pH	4.0	4.5	5.0	6.0	7.0	
La <sub>2</sub> O <sub>3</sub> taken, mg. oxine method	40.8	81.6	102.0	237.0	395.0	
La <sub>2</sub> O <sub>3</sub> taken, mg. using succinic acid	31.2	67.4	86.9	224.6	378.0	
pH	7.0					

TABLE VI

La <sub>2</sub> O <sub>3</sub> taken, mg. oxine method	64.0		55.4		64.0	
La <sub>2</sub> O <sub>3</sub> found, 50.6 57.2 59.2 59.4 58.4 mg. using adipic acid			52.8		59.2 59.0	
pH	4.0	4.8	5.3	5.7	6.2	6.4 6.8 7.0

It has been found that cerium (IV) is partially precipitated by malonic acid but succinic, adipic and phthalic acids precipitate it nearly quantitatively in the pH range 3.0-7.0. Lanthanum forms a soluble complex with malonic acid in the pH range 3.0-7.0 while it is largely though not quantitatively precipitated by succinic and adipic acids in the pH range 4.0-7.0.

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### ISOLATION OF ISOQUERCITRIN FROM THE FLOWERS OF *OPUNTIA DILLENII*

In an earlier communication Nair and Subramanian<sup>1</sup> described the isolation of quercetin and isorhamnetin from the yellow flowers of *Opuntia dillenii* (collected during March-April 1961) and observed that the flavonols were present possibly as their 3-glycosides, which could not be isolated and identified as such. As a result of extraction of another batch of the flowers (collected during June-July 1963) the identification of the flavonol glycoside isolated is now reported: isoquercitrin has been obtained in about 0.2% yield, but no glycoside of isorhamnetin could be isolated.

Fresh petals of *O. dillenii* were extracted thrice with methanol by cold maceration and the combined extract concentrated *in vacuo* to remove all methanol. The aqueous concentrate was shaken repeatedly with petroleum ether (40-60°) and ether in succession to remove the waxy matter and the free flavonols which consisted of mainly quercetin with only traces of isorhamnetin.

The aqueous layer after ether shaking was kept in an ice-chest for about a month, when yellow solid separated which after two recrystallisations from methanol-ether came out as pale yellow needles, m.p. 213-14°; mixed m.p. with an authentic sample of isoquercitrin<sup>2</sup> was undepressed. The identity of the glycoside as isoquercitrin was further confirmed by direct comparison of the colour reactions, co-chromatography with an authentic sample and acid hydrolysis to yield quercetin and glucose only.

The mother liquor after removal of the glycoside was hydrolysed with 7% sulphuric acid and the aglycone was found to be quercetin only by paper chromatography; no spot due to isorhamnetin could be detected.

The occurrence of isoquercitrin with some free quercetin and practically no isorhamnetin

(3'-methylether of quercetin) or its glycoside could be ascribed to the effect of seasonal variations (and the place of collection) as in the case of the flowers of *Moringa pterygosperma*,<sup>3</sup> *Bauhinia tomentosa*<sup>2</sup> and *Thespesia populnea*<sup>4</sup> and in the peel of the fruits of *Citrus aurantium*<sup>5-6</sup> reported to contain auranetin or 5-O-desmethylnobiletin. It may also be mentioned that the flowers of *O. ficus-indica*<sup>7</sup> were reported to contain only isorhamnetin.

Medical College, A. G. R. NAIR.  
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### EFFECT OF PURINES ON THE ACETYLCHOLINE CONTENT OF RAT BRAIN

ADENOSINE TRIPHOSPHATE (ATP), a purine, is essential for the synthesis of acetylcholine, which is related to the functional activities of brain. Bose *et al.*<sup>2</sup> reported on the depressant effect of purines on the cholinesterase activity in rat brain. This work has been extended to the study of their effects on the acetylcholine content of rat brain.

Adult albino rats, weighing 80-110 gm., were utilised for the experiments. The animals were sacrificed by rapid freezing method and the brain, with the exclusion of cerebellum, was quickly removed, dried between the folds of filter-paper, weighed and homogenised in a previously chilled glass mortar, containing silica, hydrochloric acid and eserinated Ringer solution. Acetylcholine was extracted and estimated by the frog rectus-technique as described earlier.<sup>1</sup> The estimation was carried out both after acute and chronic administrations of the drugs in 6 groups of 10 rats each. In the former, the drugs were injected intraperitoneally and the animals sacrificed after 2 hours, while in the latter, the drugs were administered orally for 10 days, after which the animals were killed and brain acetylcholine content determined.

Acetylcholine content of brain was found to be increased after acute administration of

theophylline but diminished after Caffeine, ATP and ADP. Theobromine did not affect it significantly (Table I). None of the drugs, on chronic administration, influenced the acetylcholine level of brain.

TABLE I  
Showing the effect of purine compounds on the  
acetylcholine content of rat brain, after  
acute administration

Drugs 40 mg./kg.	Ach. content in $\mu\text{g./gm.}$ of brain $\pm$ S.D. (S.E.)	Per cent. change	S.R.
Control	.. $2.46 \pm 0.37$ (0.1)	..	..
Caffeine	.. $1.60 \pm 0.20$ (0.09)	-34.9	6.30
Theophylline	.. $4.12 \pm 0.12$ (0.54)	+67.4	3.07
Theobromine	.. $2.48 \pm 0.43$ (0.19)	+ 0.81	..
ATP	.. $1.83 \pm 0.23$ (0.14)	-25.60	3.70
ADP	.. $2.06 \pm 0.18$ (0.07)	-16.20	3.30

The average acetylcholine content in brain tissues of control rats has been found to be  $2.46 \pm 0.37 \mu\text{g./gm.}$  This is in agreement with the values obtained by Elliot and Crossland.<sup>3</sup>

The reduction of acetylcholine in the case of caffeine appears to be due to its greater stimulant properties, compared to other xanthines, with consequent increase in the metabolism of this hormone. Theophylline, which has little stimulant action, increased the same partly, due, probably, to its anticholinesterase property.<sup>2</sup> It is interesting to note that ATP and ADP diminished acetylcholine level in spite of their role in its synthesis. It is likely, that besides acting as energy donors, these molecules, at high concentrations, might produce an opposite effect.

Department of Pharmacology, B. C. BOSE.  
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### MALATHION AS A REPELLENT FOR RATS

In spite of the tremendous losses caused by rats to stored commodities throughout the world and the intensive investigations in evolving safe and economic methods for their control, no specific poison or repellent has been discovered for practical application. Rodenticides which are in current usage have high order of toxicity also to man.<sup>1</sup> Researches on insect

proofing of jute bags and other bulk packages have led to the development of pesticidal compositions suitable for practical application especially for preventing reinfestation from outside sources.<sup>2-3</sup> Although, the insecticides have been successfully used for preventing the cross-infestation of stored commodities by the insects, the deterrence or repellency of these insecticidal chemicals to rodent attacks have not been evaluated. Twenty-seven pesticidal solutions were, therefore, tested by impregnating sacklets containing rat baits for their repellency or otherwise to *Rattus rattus*.

Out of the chemicals tested, eugenol and malathion [S (1-2-dicarbethoxyethyl) 0, 0-dimethyl dithiophosphate] showed high degree of repellency to *Rattus rattus*. A protective action from rodent attack could be exerted for a period of even more than 20 days with a concentration of 20 mg./sq.ft. of malathion on the bag surface. As malathion was found to be possessing high degree of repellency to rats and also could control insect infestation, the persistence of malathion on gunny sacklet when sprayed with different carriers was studied.

In this experiment, malathion was carried in different carriers (Table I) and the viscosities of the formulations were determined with Redwood's viscometer. Standard size jute bags were sprayed at the rate of 20 mg./sq.ft. area with malathion. Number of days of protection from rodent attack offered by different formulations of malathion were recorded and the concentrations of malathion were estimated by the method of Norris *et al.*<sup>4</sup> The data are presented in Table I.

TABLE I

Effect of carriers on the persistence of malathion and duration of repellency on treated gunny bags

(Initial concentration of malathion applied 20 mg./sq.ft.)

	Viscosity Redwoods No. 1 (Secs.)	Repellency (No. of days)		Malathion (% retention) after 90 days	
		Max.	Min.	Max.	Min.
Alcohol .. Below	30	12	7	0	..
Kerosene .. Below	30	17	6	0	..
Lubricating oil (SAE-10)	261	19	8	0	..
Lubricating oil (SAE-30)	794	26	19	10	9
Groundnut oil ..	240	44	21	28	22
Dutrex-3 ..	161	69	42	48	34
Dutrex-55 Above	2,000	165	88	57	42

Dutrex-batching oil used in textile industry (Burmah Shell).

It is interesting to note that malathion which is of low mammalian toxicity and of high toxicity to insects<sup>5</sup> could exert a high degree of repellent action on rats. This new property of malathion seems to open up excellent possibilities for use of malathion formulation for preventing rodent damage to stored commodities. The results also indicated that with a high viscosity oil the persistence and rodent repellent action of malathion could be prolonged even upto a period of 165 days with a low concentration as that of 20 mg./sq.ft.

Highly poisonous chemicals such as barium carbonate, zinc phosphide, red squill, sodium fluoroacetate, alpha-naphthylthiourea, coumarin derivatives, strychnine and thallium salts are in current use for poisoning of rats by baiting techniques.<sup>1</sup> In food storages the risks of contaminating the materials and poisoning of pets and children present very difficult problems for their extensive applications for the control of rats in warehouses and domestic dwellings. This new approach for rodent-proofing of stacks and warehouses by spraying insecticidal chemical of low mammalian toxicity at safe levels for human being, to deter the attacks by rats, seems to offer great scope for wide application.

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Central Food Techno- S. K. MAJUMDER.

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## KONDAPALLE OF ANDHRA PRADESH : A NEW LOCALITY FOR ZINC MINERALISATION

CHROMITE occurs in workable quantity in Kondapalle (longitude 80° 30' to 35' and latitude 16° 35' to 16° 45') in Krishna District Andhra Pradesh. Sri Rama Rao (1947) and Venkatappayya (1948) considered this occurrence as "late magmatic" and "hydrothermal". The author describes here sphalerite in association

with the chromite and the charnockite from this area for the first time. Ramdohr (1960) also suggests that the zinc mineralisation is common with charnockites.

The sphalerite is found as small streaks or patches along the cleavages of magnetite (Fig. 1). The mineral is brown in colour, non-pleochroic, low in reflectivity which is still low in oil, low in hardness, isotropic and shows brown internal reflections. The sphalerite shows youngest paragenetic relationship with other minerals described below.

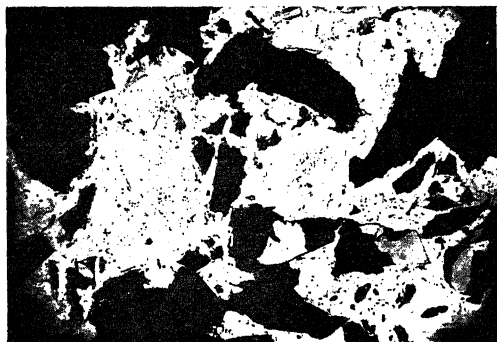


FIG. 1. The grey magnetite is at the centre with brown sphalerite along the cleavage. The white hematite along the borders is flaky and replacing early serpentine,  $\times 20$ .

The ore minerals in association with the sphalerite are chromite, pyrrhotite, pentlandite, ilmenite, and magnetite. The pentlandite and the pyrrhotite occur in intergranular space of the chromite and the silicates and exhibit an younger relationship. Serpentine cuts into the chromite, pyrrhotite, and the pentlandite, but not into the magnetite, suggesting that the magnetite is formed much later than the serpentine. Further it is found that the magnetite alters to hematite and replaces the early formed serpentine along the borders. The secondary hematite is flaky in form and it replaces the serpentine.

The formation of the sphalerite is probably simultaneous with the hematite. It is formed at low temperatures, later than serpentine and formed either as direct product of last phases of mineralisation or by the alteration of magnetite which may be zinc-bearing. Hydrogen sulphide fumes in the end phases of ore mineralisation (pneumatolysis) may come in contact with the magnetite which is disintegrating; the zinc so liberated would have combined with sulphur forming the sphalerite observed. In conclusion, the mineralisation being in the vicinity of the charnockite and

chromite, similar investigations in other areas may be profitable.

Geology Department,  
Andhra University,  
October 28, 1963.

J. S. R. KRISHNA RAO.

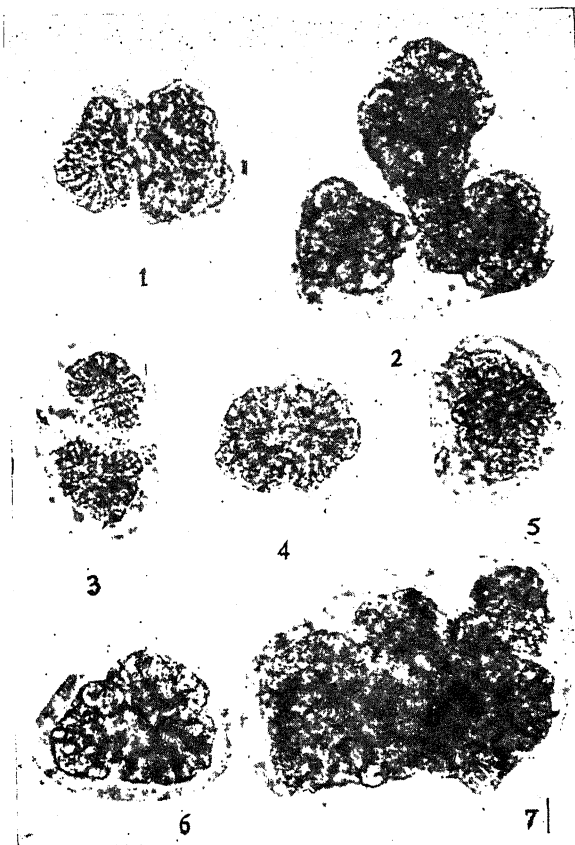
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### A NOTE ON THE OCCURRENCE OF *BOTRYOCOCCUS* IN THE MIOCENE LIGNITES OF KERALA\*

*Botryococcus* is known for quite sometime as fossil components of peats, lignites and other deposits in India and elsewhere. In India, it has been recorded from the Eocene lignite beds of Cutch<sup>7</sup> and Palana<sup>4</sup> (Rajasthan), Eocene cherts of Mohgaonkalan<sup>6</sup> (Madhya Pradesh) and also from the Oligocene-Miocene deposits of Australia.<sup>1</sup> The occurrence of *Botryococcus* in the lignite beds from Pathirapally, Alleppy District, Kerala, has been noted for the first time by the author during the spore and pollen analysis of certain lignite samples from this area. The alga was recovered from the residues after treating with 10% KOH for about half an hour.

The material reveals the presence of spores and pollen and numerous colonies of *Botryococcus* cells which are yellow to yellowish-green in colour. *Botryococcus* is a cosmopolitan colonial alga found both in brackish and freshwater lakes and ponds. The colonies are generally spherical in shape and vary in size depending upon the daughter colonies which remain attached to one another. The colonies in the present material range from  $15\mu$  to  $140\mu$  in size. This algal species resembles very much the present-day oil-bearing brackish-water alga, *Botryococcus braunii*.

The author has also noted in this material interesting spores and pollen grains referable to *Schizaceae* and *Polypodiaceae* families which closely resemble the micro-floral assemblages already described by Rao and Vimal,<sup>3</sup> Vimal,<sup>7</sup> and Ramanujam<sup>5</sup> from the Warkali lignites which are believed to be of Miocene age (Krishnan<sup>2</sup>). Thus a Miocene age could be assigned to these lignites in which *Botryococcus* occurs.



FIGS. 1-7. All figures,  $\times 500$ .

The author wishes to acknowledge his thanks to the Officer-in-Charge, Kerala Circle, Geological Survey of India, for providing the samples and to Shri M. V. A. Sastry for his helpful suggestions.

Central Palaeontological Labs., A. CHANDRA.  
Geological Survey of India,  
Calcutta, October 6, 1963.

\* Published with the kind permission of the Director-General, Geological Survey of India, Calcutta.

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# EFFECT OF REMOVAL OF NEURO-SECRETORY CELLS ON SPAWNING IN THE MUSSEL, *MODIOLUS DEMISSUS* (MOLLUSCA: LAMELLIBRANCHIATA)

IN a previous communication<sup>1</sup> the author reported the presence of neurosecretory cells in the central nervous system of the mussel, *Modiolus demissus*. The present investigation was aimed at the problem of the function of the neurosecretory cells in *Modiolus*.

All the mussels used in the present investigation were collected from the York river and the experiments were conducted in the physiology laboratory of the Virginia Institute of Marine Sciences, Gloucester Point, U.S.A. They ranged in shell length from 25 to 40 mm. Ablation of the cerebral and visceral ganglia was attempted on fully ripe male and female individuals in July, 1962, to study the effect on spawning. For operation, first one shell valve was carefully removed without causing any injury to the animal. Since it is rather difficult to remove just the cerebral ganglia, the ganglia are ablated together with a bit of the labial palps. The visceral ganglia, which are located on the anteroventral surface of the posterior adductor muscle in a slight depression, are removed along with a bit of muscle tissue. In the control animal only one shell valve was removed without ablating the ganglia. With a little bit of practice, the entire operation takes about 2 minutes. After the operation, the individual mussels were kept in finger bowls and the water was changed at frequent intervals.

After ablation of the cerebral or visceral ganglia the animals were kept for 1-3 days and then fixed in Bouin's fluid and pieces of gonad were removed for histological study. The animals were considered to have partially spawned if there was a shrinkage of follicles by discharge of some of the eggs while the remaining undischarged eggs were grouped together. In males of partially spawned animals the lumen of the follicles was empty due to recent discharge of large quantities of ripe spermatozoa. The results are presented in Table I.

Out of 25 cerebralectomized females, 19 have partially discharged the eggs while 21 out of 25 males have partially spawned. On the other hand, removal of visceral ganglia did not produce appreciable spawning reaction in males and females as compared with the controls. Although the number of observations is rather low, it may tentatively be concluded that the

TABLE I  
Effect of removal of the cerebral or visceral ganglia on spawning in *Modiolus demissus*

Type of operation	Females		Males	
	No. of animals discharged eggs	No. of animals that did not respond	No. of animals partially spawned	No. of animals that did not respond
Ablation of cerebral ganglia	19	6	21	4
Ablation of visceral ganglia	3	17	4	16
Control	4	18	6	24

removal of the cerebral ganglia hastens the spawning in females and males. Similar results are reported by Lubet<sup>2</sup> in two bivalves, *Mytilus* and *Chlamys*; in these molluscs disappearance of the products of the neurosecretion of the cerebral ganglia seems to be necessary for the emission of the gametes. In the oyster, *Crassostrea virginica*, ablation of the cerebral ganglia hastened the spawning reaction in the females and to a less degree in males.<sup>3</sup>

The author wishes to express his sincere thanks to Prof. P. N. Ganapati for his keen interest and valuable comments.

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#### ON THE OCCURRENCE OF THE DEEP-WATER PRAWN *PENAEOPSIS* *RECTACUTUS* (SPENCE BATE) OFF THE KERALA COAST

*Penaeopsis rectacutus* was first collected by 'Challenger'<sup>1</sup> off Fiji and Philippine Islands from 95 to 315 fathoms. Though Challenger caught several specimens in dredge and trawl from a muddy bottom, only a single perfect female specimen was present and so the type description of the species is based on this specimen. Later on, 'Investigator'<sup>2,3</sup> discovered 76 specimens off Pulicat (Madras) from 133, and 145-250 fathoms and off Andaman Islands 188-419 fathoms; 'Valdivia'<sup>4</sup> collected 2 female specimens from 162 fathoms off Nicobar and 'John Murray'<sup>5</sup> 40 females and 20 males from the Gulf of Aden 101 fathoms. Owing to the differences pointed out for the petasma, Ramadan<sup>5</sup> doubts

that the specimens attributed by De Man<sup>6</sup> as *P. rectacutus* collected from Indonesian Seas, may possibly belong to some other species. De Man himself observes a number of differences from the 'Investigator' specimens described by Alcock<sup>3</sup> in the nature of the rostrum, carapace and abdomen.

The University of Kerala Research Vessel 'Conch' during her offshore cruises from 1958-61 collected numerous specimens of *P. rectacutus* off the Kerala Coast from depths varying from 100-180 fathoms. A 6 ft. beam trawl was used for the investigation and of the 71 deep-water stations investigated, *P. rectacutus* was collected from 15, all the stations having a bottom formed of sand and mud mixed with shell fragments.

Though *P. rectacutus* was at times observed along with the deep-water prawn *Penaeopsis philippi* (Spence Bate), the distribution of the former seems to be slightly different from the latter. While *P. philippi* is found in abundance near the 100 fathoms line extending from Anjengo to Mangalore<sup>7,8</sup> *P. rectacutus* is collected only north of Cochin and extending up to Calicut. *P. rectacutus* is also found to prefer a greater depth than *P. philippi* and is obtained in large numbers off Calicut, 180 fathoms. From the Indian waters, *P. rectacutus* has been previously recorded only from the East Coast and so the present record extends the distribution of the species to the West Coast also.

The specimens of *P. rectacutus* in the present collection agree with the description and figures of Alcock.<sup>3</sup> The largest female is 106 mm. long with the flagellum of second antenna more than twice the length of the animal. However, the rostrum is not straight as in the figure of Alcock, but having a double curve, which is slightly more pronounced than in the figure of Ramadan.<sup>5</sup> It bears 10-14 teeth dorsally and in female extends beyond the extremity of the scaphocerite and antennular peduncle. The ridges on the sides of the carapace which are characteristic in this species, closely agree with those described by Alcock and Ramadan. The nature of the telson is almost the same as that of the John Murray specimens, generally with 3 pairs of movable spines in male as well as in female, besides the fixed pair. All peraeopods bear rudimentary exopods, those of the hinder ones being smaller.

The live colour of *P. rectacutus* is dark brown with a reddish tint and hence it can be easily differentiated from *P. philippi* which is golden-brown. Preserved specimens are darker.

Oceanographic Laboratory, C. V. KURIAN.  
Ernakulam, October 25, 1963.

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### ON A NEW RECORD OF HOST SPECIES OF ISOPOD PARASITE, *BOPYRUS*

THE family Bopyridae comprises parasitic Isopods, lodged in the gill chamber of Decapod crustacea, mainly prawns of the family Palæmonidae, causing a strong lateral tubercosity on one side of the cephalothoracic region. The swelling is due to the presence of a large size female, lying in association with a very small male.

*Bopyrus* is one of the oldest genus of the family, being established as early as 1804 by Latreille (Sars, 1896). The genus, until 1923, was represented by only one species *Bopyrus squillarium* Latreille, although several authors established different species according to host species of prawns which, later on, were shown to be synonymous (Chopra, 1923). In his work, Chopra described *bimaculatus* nov. as a variety of *B. squillarium* from Indian waters. Another species, subsequently added, is *Bopyrus stebbingi* Nierstrasz and Brender à Brandis, a parasite from an unknown host occurring in the eastern parts of the Indo-Pacific region (Chopra, 1930). The European host species recorded are *Palæmon serratus*, *P. squilla*, *P. xiphius*, and species all over the Indo-Pacific region, from Hongkong in the east to the coast of Africa in the west, is *P. serrifer* (Chopra, 1930). From Indian waters, host species recorded are *P. styliferus* collected from Gangetic delta and a single specimen from the Bay of Bengal, and *P. serrifer* from Bombay (Chopra, 1923, 1930).

Recently, while investigating the bottom fauna off Bombay up to a depth of about 12 fathoms, a number of prawns of different species were collected by using an anchor-dredge. Amongst these, one of the specimens of *Palæmon*

*tenuipes* was found infested with *Bopyrus* parasite. It was found in the left branchial chamber, causing a tumour of about 7 mm. The size of the female was about 8 mm. in its greatest length and 5 mm. across the thoracic somite. The male was 1.2 mm. long and 0.4 mm. broad across the fourth thoracic somite. The incubatory pouch of female was found full of eggs. The specimen found on *P. tenuipes* has been identified as *B. squillarium*, owing to the absence of the characteristics typical of the variety, i.e., a pair of dark spots on the dorsal surface of the abdomen of female, and the abdomen not longer than broad in case of male. This record, therefore, forms the extension of the host species of this Isopod parasite.

The authors are grateful to Dr. C. V. Kulkarni, Director, for the facilities provided.

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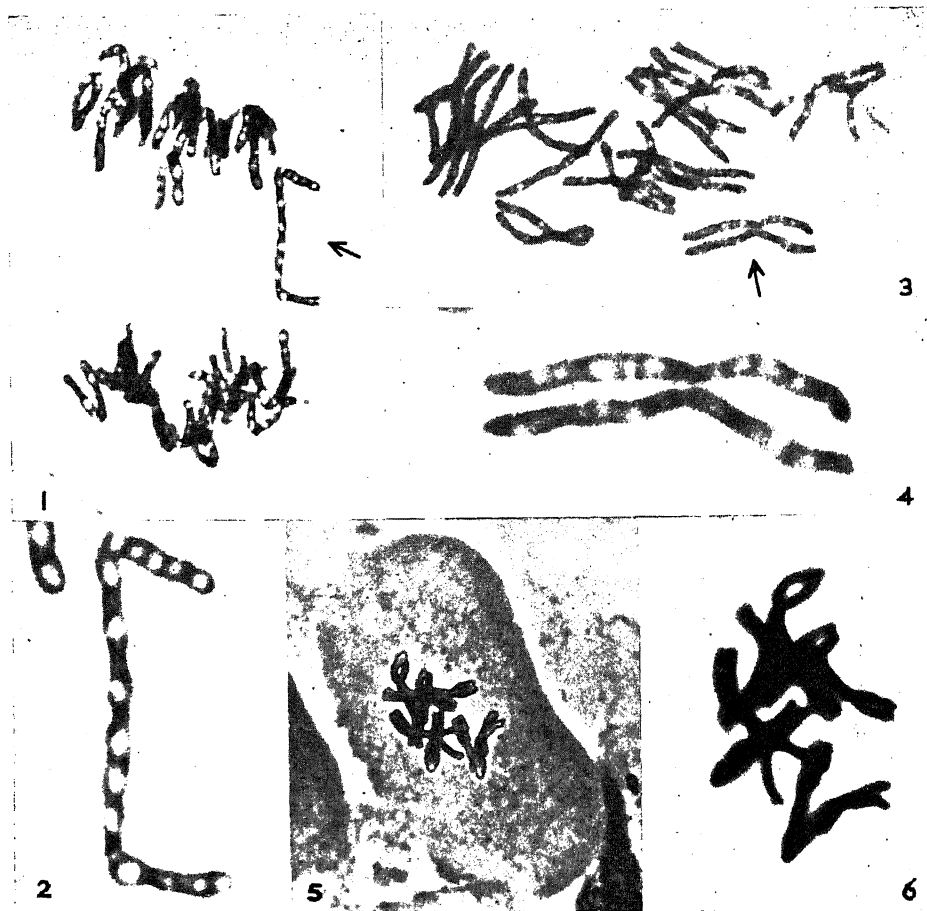
### THE STRUCTURE OF THE DIPLO-CHROMOSOMES AND A RARE HAPLOID CELL IN THE ROOTS OF *ALLIUM CEPA*

In the meristematic cells of *Allium cepa*, the structural details of the chromosomes could be revealed easily by simple techniques.<sup>1-3</sup> The chromosomes were found to be quadri-partite at metaphase and bi-partite at anaphase. The caduceus coiling of a pair of chromonemata at anaphase is distinct in the dicentric chromosome forming an anaphase bridge in Figs. 1 and 2. Since the two chromatids are wound round each other at metaphase, material has to be processed with care to reveal the quadri-partite configuration. It is probably this limitation which led Taylor<sup>4</sup> to state that the structure of the chromosomes could rarely be made out at pro- and meta-phases.

The process of separation of the chromatids beginning with the centromere and proceeding towards the tips in normal divisions is reversed on treatment with colchicine and the two halves of a diplo-chromosome remain connected by an unsplit centromere.<sup>5</sup> During this process the chromatids uncoil and are sometimes aligned almost parallel to each other. Consequently the structure of each half of a diplo-chromosome

should be superposable on that of a normal anaphase chromosome.

and 4). It has been suggested that treatment with colchicine and other chemicals<sup>6-8</sup> may



FIGS. 1-6. Figs. 1 and 2 Direct hydrolysis in N HCl and haematoxylin squash. Figs. 1. An anaphase with a dicentric chromosome,  $\times$  ca 1,300. Fig. 2. Enlargement of the dicentric chromosome indicated by the arrow in Fig. 1,  $\times$  ca. 3,450. Fig. 3. Diplo-chromosomes revealing the structure,  $\times$  ca. 1,450. Fig. 4. Enlargement of a diplo-chromosome (arrow in Fig. 3),  $\times$  ca. 4,100. Figs. 5 and 6. Haploid number of diplo-chromosomes. Fig. 5,  $\times$  ca. 1,000. Fig. 6,  $\times$  ca. 1,700.

Roots from a freshly germinated bulb were immersed in a 0.2% solution of colchicine at room temperature for 2 to 18½ hours, washed well in water, hydrolysed in N HCl at 60° C. for 8 min., stained with Heidenhain's haematoxylin and then squashed.<sup>1</sup> A lighter staining was preferred to highlight the structural details.

The pretreatment for 2 hours did not produce an excessive contraction of the chromosomes. In those instances where the halves of the diplo-chromosomes are almost parallel (Figs. 3 and 4) each chromatid (Fig. 4) appears to be composed of a pair of caduceously coiled chromonemata and has the typical configuration of an anaphase chromosome (compare Figs. 2

remove the matrix from the chromosomes. When a selective staining of the chromonemata is possible even in untreated roots, it would appear that colchicine merely contracts and separates the chromatids and does not have any selective action on the matrix.

In normal roots of *A. cepa* the occurrence of cells with a viable haploid complement of chromosomes is said to be a very rare phenomenon.<sup>9-12</sup> Isolated instances of a reductional grouping and a cell with a haploid chromosome complement were reported recently.<sup>13</sup> The discovery of a cell with a haploid complement of diplo-chromosomes in the haematoxylin squash of a root exposed to a 0.2% solution of



colchicine overnight (18½ hrs.) and fixed in acetic alcohol became interesting in this context. Phase micrograph 5 indicates that this haploid complement is that of a single cell. The chromosome number is clear in Fig. 6 taken under ordinary illumination. The presence of diplo-chromosomes can only be due to a chromosomal replication after the formation of the haploid cell and as such is indicative of the rare origin of viable haploid cells from reductional groupings.<sup>13</sup>

I am grateful to Drs. M. K. Subramaniam and Saraswathy Subramaniam for critical discussions. Cytogenetics Laboratory, S. SUBRAMANYAM. Department of Biochemistry, Indian Institute of Science, Bangalore-12, January 21, 1964.

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### EARTHWORMS AND AMINO-ACIDS IN SOIL

BRAHMACHARI analysed chromatographically aqueous extracts of the earthworm castings and soil at different levels from the garden of the Indian Statistical Institute, Calcutta, and obtained four ninhydrin-positive spots from the top soil as well as from the casts. At a depth of six inches the number of acids decreased to three. None were found in the subsoil. Since earthworms are known to build top soil by ingesting and transporting the subsoil, it was concluded that amino-acids were concentrated during this process.

In the present investigation, free amino-acids of the castings of two species of earthworms were compared to the parent soil under culture conditions.

*Pheretima posthuma* L. Vaill and *Pontoscolex corethrurus* Fr. Mull. were cultured in boxes

according to Tembe and Dubash.<sup>2</sup> Sub-cultures were then prepared according to Barley<sup>3</sup> as adapted by Dubash and Ganti.<sup>4</sup> Before preparing the sub-cultures, the animals were fed moist filter-paper till their guts were completely cleared of all soil. Castings were collected after 24 hr., air-dried and stored in polythene bags. The samples were extracted with 80% ethyl alcohol on a mechanical shaker and then electrolytically desalted as described by Block *et al.*<sup>5</sup> Final extracts were prepared in 10% isopropanol and kept in the refrigerator. Amino-acids were separated by circular paper chromatography using *n*-butanol-acetic acid-water (4:1:5) and identified from the Rf values obtained with synthetic amino-acid mixtures. The results are given in Table I.

TABLE I

A comparison of the amino-acids obtained in soil and castings along with their Rf values

Amino-acid	Rf value	Soil	Earthworm castings	
			<i>P. posthuma</i>	<i>P. corethrurus</i>
Leucine (s)	0.83	+	+	+
Valine	0.714	+	+	+
Tyrosine	0.66	+	+	+
$\alpha$ -alanine	0.52	+	+	+
Lysine	0.47	+	+	+
Arginine	0.415	*	+	+
Cystine	0.28	—	—	+

+ Indicates presence; \* Indicates traces; — Indicates absence.

Results show that free amino-acids are not depleted by the earthworms. This is in line with the observation of Baldwin.<sup>6</sup> Arginine, which was as a trace in soil, is concentrated in the castings of both the animals. In *Pontoscolex corethrurus* cystine appeared in the castings even though it was absent from the soil. It could have originated in the body either through transamination or alternatively it may have been derived from the intestinal microflora. Small as these changes appear to be, they were brought about by a single passage through the intestine. Repeated ingestion during building up of the top soil may increase the concentration. Amino-acids are not only substrates for ammonification but are also capable of being absorbed and utilized for growth by intact plants.<sup>7</sup> Hence, their conservation and concentration by earthworms is noteworthy.

We are indebted to Dr. D. V. Bal, Director, Institute of Science, Prof. Mrs. E. Gonzalves, former Head of the Botany Department, Institute of Science, and Principal T. G. Khubchandani of the Jahind College and the Basant

Singh Institute of Science, Bombay, for their encouragement and inspiration.

Jaihind College and P. J. DUBASH.  
Basant Singh Institute, S. S. GANTI.  
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**AGATHIS FESTIVA MUESEBECK,  
A NEW BRACONID PARASITE OF  
THE LAC PREDATOR,  
HOLCOCERA PULVEREA, IN INDIA  
(INSECTA, HYMENOPTERA,  
BRACONIDAE)**

*Holcocera pulverea* is one of the major insect predators of lac insects and causes considerable damage to lac encrustations in India. Its known natural enemies have been utilised to control it biologically but the results have not been satisfactory. While searching for new insect enemies of lac predators, the author came across a braconid parasite in 1956 which emerged from caged lac sticks at Ranchi, Bihar. In order to ascertain its correct host, the larvæ of the two lac predators, viz., *Eublemma amabilis* and *Holcocera pulverea* were removed from infested lac sticks and kept under observation separately in glass tubes. Additional specimens of the same braconid parasite were obtained from *Holcocera pulverea* larvæ, a single parasite larva developing inside the host larva. Upon examination this parasite was found to be a species of the genus *Agathis* and specimens were sent to Dr. C. F. W. Muesebeck of the U.S. National Museum, Washington. He reported it to be the same as *Agathis festiva* Muesebeck,<sup>1</sup> a species which he had described as a parasite of the Oriental fruit moth, *Grapholitha molesta*, from China in 1953. This species has not been previously reported from India and therefore it is being recorded here for the first time from India as an endoparasite of *Holcocera pulverea*. Recently, however, it has also been reared at the Indian Lac Research Institute, Namkum, Ranchi,<sup>2</sup> but no specific identity has been mentioned.

Another species of *Agathis*, viz., *A. bischoffi* Fahringer<sup>3</sup> has been recorded previously from lac in India which differs from the present species in having a rostriform head, pale head and thorax and infumated wings.

Nothing much is known about the biology of *A. festiva*. Further attempts to get this parasite proved futile. It appears to be an occasional parasite of *Holcocera pulverea* and perhaps other lepidopterous larvæ living in concealed situations. Further study on its biology and distribution would help in assessing its role in the biological control of lac predators.

Department of Zoology, V. K. GUPTA.  
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**'KAMRAKH' (AVERRHOA CARAM-  
BOLA L.), A NEW HOST OF  
TRICHOTHECIUM ROSEUM LINK**

DURING 1962 some specimens of an undescribed fruit disease of 'Kamrakh' (*Averrhoa carambola* L.) were collected by the authors from the local fruit market. In the early stages, the disease appears as a firm dark brown rot, which subsequently develops into a soft watery black rot. Its surface becomes partially overspread with a pink orange fungal growth. Monosporic isolations were made, and the organism was grown on potato-dextrose agar slants. The causal organism was determined to be *Trichothecium roseum* Link.<sup>1</sup> This fungus has not been reported to be associated with any disease of *carambola* plants, and is the first record from India or elsewhere.

At first, a light brown lesion appears at the point of infection. The lesions typically radiate from any point of injury on the surface of the fruits which may be at any stage of their development. The invasion of new tissues often continues until the entire fruit is discoloured. *T. roseum* causes a firm dark brown rot. At advanced stages a discoid sporulation of light pink to orange pink conidia appears. The orange pink colouration and powdery texture develop with age. The intensity of infection varies with environmental conditions. The diseased area, in nature, is usually attacked by secondary organisms which produce a soft watery dark brown to black rot. The number of isolations are recorded in Table I.

TABLE I

Frequency of *Trichothecium roseum* among isolates obtained from 40 tissue fragments from 10 rotted *Averrhoa carambola* fruits in Allahabad fruit market, September, 1962

Source	Number of representative fruits used	Date collected	Number of tissue fragments		
			Cultured	Yielding <i>T. roseum</i>	Yielding other organisms
Collection I ..	2	Sept. 11	8	6	3
" II ..	1	" 17	4	4	1
" III ..	1	" 19	4	4	0
" IV ..	3	" 28	12	9	2
" V ..	3	" 29	12	8	3

Tissue fragments from diseased fruits listed in Table I yielded isolates of *T. roseum*, the fungus was found to be present in 31 out of 40 tissue plantings. Conidia from each isolate were inoculated into green 'Kamrakh' fruits. A drop of conidial suspension was kept at the apical end of the fruit which had been previously sterilized. The skin of the fruit was punctured with a needle at the point, where the inoculum was placed. These inoculated fruits were kept in moist chambers at a controlled temperature ( $25 \pm 1^\circ \text{C}$ .) and observed daily. Characteristic symptoms were observable in each fruit after 2-3 days. The identical conidial suspension was placed upon unwounded 'Kamrakh' fruits, but in such cases, the disease symptoms were not observed. Tissue isolations were made from each diseased fruit and only *T. roseum* was recovered. This isolate of *T. roseum* was inoculated into apples, bananas, oranges, pears and quinces by puncture method and a firm brown rot was produced in every case.



FIG. 1

**Morphology of the fungus.**—The causal organism has been identified as *T. roseum* Link (Fig. 1). On potato-dextrose agar the hyphal filaments of new growth are irregularly septate. The septa increase with age and at maturity septation becomes quite regular. At first, the colonies are thin, white and radiating, turning to pale pink and at maturity they appear orange pink. Growth is floccose, prostrate and limited. Conidiophores are upright, simple and occasionally septate with orange-pink, bicelled (occasionally unicelled) smooth conidia borne acrogenously. The conidia are variable in conformation, being primarily pyriform or oblong-ovate. Conidia measure  $11.4-21.1$  by  $4.2-11.9 \mu$ ; the basal cell of the conidium is truncate to pointed at its attachment and is  $5.7-12.3 \mu$  long as compared to  $5.3-16.6 \mu$  for the terminal cell.

We thank Sri. M. P. Srivastava for taking the photomicrograph of the fungus. We also thank Council of Scientific and Industrial Research for the award of Junior Research Fellowship to one of us (R. K. K.).

Department of Botany,  
The University,  
Allahabad, October 5, 1963.

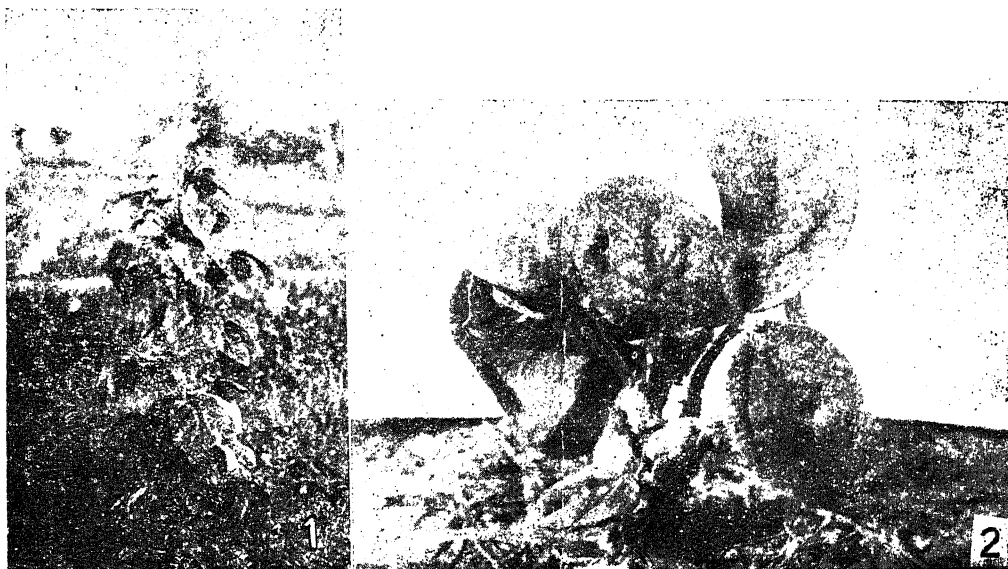
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## STUDIES WITH $C_1$ -AUTOTETRAPLOID GUAR

GUAR [*Cyamopsis tetragonoloba* (Linn.) Taub.] is an important legume of the tribe Galageae (subfamily Papilionatae) grown extensively as a fodder-, vegetable- and green-manuring crop. Two types of this plant are available; one with bushy habit, profuse branching and smaller pods, and the second, erect, more or less branchless, with rather large pods. Five varieties (G I-V) of the crop released for general cultivation by the Punjab Department of Agriculture were collected to study the effect of polyploidy on this plant. Types II and III of this collection represent the first group, and the remaining — I, IV and V — the second.

Colchicine was applied in aqueous solutions of 0.025, 0.05 and 0.10% for 12 and 24 hr. to 30 germinated seeds and an equal number of seedlings per treatment. No success was



FIGS. 1-2. Fig. 1. A diploid plant of variety G.IV (1/19 approx.). Fig. 2. A polyploid plant of G.IV (1/7 approx.).

recorded except getting a mixoploid plant (already reported<sup>1</sup>). In another treatment where colchicine was used in paste with lanolin at the rate of 0.05, 0.10, and 0.20% applied to the growing plumule of 40 young seedlings in each case success of the order of 8.16% was met with. 0.20% was the most effective concentration.

Polyploids were recognised by their slow growth, very small stature, short life, very poor fertility and altered morphology. Of all the polyploids only those from G.IV bore flowers; other types remaining completely flowerless during the two attempts (1958, 1959).

For cytological analysis buds were fixed in Cornoy's fluid from each suspected plant separately. All the PMC's studied gave  $2n : 28$  chromosomes confirming autotetraploid nature; the diploid number being  $14$ .<sup>2</sup> The plant hitherto mentioned as mixoploid<sup>1</sup> gave  $2n = 28$  and  $26$ .

Of the 588 chromosomes studied at metaphase-I, 504 came together as quadrivalents, 46 as bivalents, 36 as trivalents and only two as univalents; thus forming out of 163 configurations  $126$  (77.3%)<sub>IV</sub>,  $23$  (14.11%)<sub>II</sub>,  $12$  (7.36%)<sub>III</sub> and  $2$  (1.23%)<sub>I</sub>. The mean frequency per cell was  $6.0$ <sub>IV</sub> +  $0.57$ <sub>III</sub> +  $1.10$ <sub>II</sub> +  $0.10$ <sub>I</sub>.

I am thankful to Professor P. N. Mehra, Head, University Department of Botany, Chandigarh, for constant advice and facilities provided,

Dept. Agric. Bot. and

Plant Pathology,

Rajasthan College of Agriculture,

Udaipur (India), October 9, 1963.

BALDEV K. VIG.

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2. —, *Ibid.*, 1953, 29, 95.

#### PRELIMINARY STUDIES ON THE PATHOGENICITY OF *BACILLUS THURINGIENSIS* ON SOME CROP PESTS

*Bacillus thuringiensis* Berliner, one of the virulent bacterial insect pathogens, is widely used for the control of crop pests in U.S.A.<sup>1</sup> and in India it has been tested and found effective on a few crop pests.<sup>2,3</sup> With a view to examine the pathogenicity of the bacterium on some crop pests of this locality studies were made and the results are reported here.

Larval stages of twelve different crop pests, 4 borers, 5 leaf-feeders and 3 leaf-miners, were selected for the studies. The larvae, collected from the field, were taken up for the experiment, after incubation in the laboratory for 3-5 days to ascertain their healthy conditions. A spore suspension of the bacterium, grown in yeast extract dextrose broth for 5 days at room temperature (28°-30° C.), was administered either through the feed or as spray to the test insects; the host plants were contaminated with

the bacterial pathogen and the insects were let in to feed; for the spray treatment the spore suspension of the bacterium, with 2% glycerine added to improve the penetration, was applied onto the insects with an atomiser. The results are summarised in Table I.

TABLE I  
Pathogenicity of *B. thuringiensis* on some crop pests in laboratory tests

Test insect	Method of treatment	Number of insects treated	Number dead
1. <i>Actias selene</i> G. (Leaf feeder on <i>Odina wodier</i> Roxb.)	Feed and spray	16	3
2. <i>Chilo zonellus</i> S. (Stem borer on <i>Sorghum vulgare</i> Pers.)	Feed	5	0
3. <i>Cnaphalocrosis medinalis</i> G. (Leaf roller on <i>Oryza sativa</i> L.)	Feed and spray	8	0
4. <i>Leucinodes orbonalis</i> G. (Fruit borer of <i>Solanum melongena</i> L.)	Feed	8	0
5. <i>Papilio demoleus</i> L. (Lemon butterfly on <i>Citrus</i> sp.)	"	8	8
6. <i>Pericyma glaucinans</i> G. (Semilooper on <i>Sesbania aculeata</i> P.)	Spray	10	6
7. <i>Procerus indicus</i> K. (Internode borer on <i>Saccharum officinarum</i> L.)	Feed and spray	7	5
8. <i>Phyllocnistis citrella</i> S. (Leaf miner on <i>Citrus</i> sp.)	Spray	14	14
9. <i>Sciropophaga nivella</i> F. (Top borer on <i>Saccharum officinarum</i> L.)	Feed	5	4
10. <i>Semiothisa perovulgata</i> (Looper on <i>Sesbania aculeata</i> P.)	Feed and spray	25	25
11. <i>Stomopteryx subseivella</i> Zell. (Leaf folder on <i>Arachis hypogaea</i> L.)	Spray	27	22
12. <i>Utethesia pulchella</i> L. (Hairy caterpillar on <i>Crotalaria juncea</i> L.)	Feed and spray	29	1

In seven out of the twelve crop pests tested there was high mortality. The bacterium could invariably be reisolated from the diseased larvæ.

Typical disease symptoms were noted in the treated larvæ; in the semilooper on daincha the larva turned from green to red and then black; in most others the larvæ became sluggish, stopped feeding, got discoloured and finally died.

To find out the effect of *B. thuringiensis* on the eggs of sugarcane top borer (*Sciropophaga nivella* F.) the eggs were either sprayed or brushed with a suspension of the bacterium in yeast extract dextrose broth. When sprayed with the bacterium the emergence was only 5% and when brushed the emergence was nil, as against 80 to 100% emergence in the control, i.e., in the eggs treated with the yeast extract medium alone. Almost similar results were obtained when the pupæ of *Utethesia pulchella* L. were treated by the bacterial suspension, either as spray or by brushing. Even the few adults emerging out of the treated pupæ were found malformed with shortened wings, lesser pigmented scales, etc.

The results reported here indicate the potentialities of *B. thuringiensis* as an insect pathogen and further confirms the findings of other workers in this field.<sup>4,5</sup> Regarding the inhibitory effect of *B. thuringiensis* on the eggs of *S. nivella* and on the pupæ of *U. pulchella*, the findings are similar to those of Vasiljevic<sup>6</sup> with *Hyphantria cunea* D.

Microbiology Laboratory, G. RANGASWAMI.  
Department of Agriculture, K. RAMAMURTHI.  
Annamalai University,  
Annamalainagar, Madras State,  
September 20, 1963.

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## REVIEWS

**Colour Change Mechanisms of Cold-Blooded Vertebrates.** By H. Waring. (Academic Press, Inc., New York-3), 1963. Pp. xii + 266. Price \$ 9.50.

Animal colour change was known to the ancients, and Aristotle described with remarkable accuracy the change in tints of devil-fishes and chameleons. Noteworthy advances have been made in the understanding of the colour change mechanisms during the present century. Von Frisch in Germany, Hogben in the United Kingdom and Parker in the United States and their respective schools may be specially mentioned in this connection.

Two kinds of pigmentary response can be distinguished, the so-called morphological, and the physiological. Morphological changes are those shared with mammals, in which there is an absolute build-up of pigments in the melanophore. Physiological changes not shown by mammals involve re-distribution of pigments within the melanophore.

The book under review is an endeavour to present a connected account of the work of Hogben's school, cognate work by others being also taken into account. Apart from a few references to work on invertebrates, birds and mammals, the present volume deals with cold-blooded vertebrates alone. Various chapters in the volume deal with the chemistry of the melanin-dispersing hormones and the mechanism of the melanophore itself. The question 'has colour change any biological advantage' is also discussed in one of the later chapters.

C. V. R.

**Ultracentrifugal Analysis in Theory and Experiment.** Edited by J. W. Williams. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xvii + 282. Price \$ 10.00.

Svedberg and Pedersen's classic treatise on the ultracentrifuge published in the year 1940 is the standard work of reference for everyone interested in the theory and practical applications of the instrument. In the quarter of a century that has elapsed since its publication, the subject has grown, and much attention has been given to the application of the ultracentrifuge in the study of macro-molecular systems and for the solution of problems in biology and

medicine. A need was felt for discussing the outstanding mathematical and operational problems of the ultracentrifuge and of bringing together important contributions made to the subject. The present work meets that need. It is a report on a conference which was held at the Rockefeller Institute, New York, in June 1962 and was attended by a representative gathering of investigators interested in the various aspects of the subject. Out of the 47 participants in the conference whose names are listed, 22 have contributed articles to the volume. These have been grouped in three parts, viz., transport theory, equilibrium theory and practice.

The article in the volume by Schachman on optical systems for sedimentation analysis has interested the reviewer very much. The illustrations appearing in it of interference patterns which exhibit the progress of sedimentation are particularly beautiful. The article by Mac Cosham describing a magnetic bearing for an ultracentrifuge which enables it to be completely independent of mechanical support is also of great interest. The first part of the volume which deals with the thermodynamics of diffusion and sedimentation and related topics should be of interest to a wider circle than those concerned with the use of the ultracentrifuge as an analytical tool. Taken altogether, the publication is evidently both timely and useful.

C. V. R.

**Metabolic Inhibitors, Vol. I.** Edited by R. M. Hochster and J. H. Quastel. (Academic Press, New York and London), 1963. Pp. xx + 669. Price \$ 26.00.

The book under review is the first volume of a comprehensive treatise on metabolic inhibitors edited by R. M. Hochster and J. H. Quastel. Analogues of various constituents of living matter such as amino-acids, nucleic acids, carbohydrates, lipids and vitamins have been described as also the inhibitors, antagonists and activators of insulin and thyroxine. As the editors have pointed out, information which is available on this subject is widely scattered in the existing literature and hence an attempt has been made to gather all the data available on a variety of metabolic inhibitors within the compass of a single volume. This has been done quite successfully by authors who are

specialists in their respective fields. Shive and Skinner have written on amino-acid analogues, while Modest, Foley and Farber have dealt in great detail on the various mechanisms of action of actinomycins. There are articles on hexose, pentose, fatty acid and phospholipids analogues as well as on purine, and pyrimidine analogues and on nucleic acids and nucleoproteins. The chapter on pyrimidine analogues is very exhaustive and the mechanism of action of fluoropyrimidine has been discussed in great detail. Mirsky in his article on the etiology of diabetes in man has presented a good account of the mechanism of action of insulin as also the antagonists of insulin action and inhibitors of insulin degradation. In the chapter on thyroxine analogues, Barker has tabulated the structural relationship and the inhibitory effect of thyroxine action of various compounds.

The book provides without doubt, a fund of literature in regard to the properties and mechanism of action of a large number of metabolic inhibitors and will prove useful to all research workers using metabolic inhibitors in their biochemical investigations.

P. S. SARMA.

**Treatise on Analytical Chemistry : Part I, Theory and Practice, Vol. 4.** Edited by I. M. Kolthoff and P. J. Elving. [Published by John Wiley and Sons (Interscience Division), 605, Third Avenue, New York-15], 1963. Pp. 1751-2705. Price \$ 25.00.

The chief object of the Publishers in bringing out the volumes in this series has already been pointed out when the previous volumes were reviewed in these columns from time to time. To put it briefly, it is to present a systematic account of all aspects of classical and modern analytical chemistry, both inorganic and organic, useful to working analytical chemists as a ready reference.

The present volume, to which 18 authors have contributed, is divided into two broad sections namely, (1) Magnetic field methods of chemical analysis and (2) Electrical methods. The general pattern followed in each article is, first to give the theoretical principles, then the experimental methods, followed by applications in different fields of study, and the results obtained.

Thus in the first article on Analytical Applications of Magnetic Susceptibility, the author L. N. Mulay, after a brief introduction of the fundamentals of magnetism, surveys the various methods of measuring magnetic susceptibility,

describes the instruments which are commercially available or are easily assembled in the laboratory for this purpose, and finally indicates the applications of the method in various branches of chemistry—inorganic, organic, bio-, and geo-, and also in industry.

The second article is on Nuclear Magnetic Resonance (NMR) and Electron Magnetic Resonance (EMR) by N. F. Chamberlain. After discussing the basic principles of magnetic resonance spectrometry, the author describes the methods of observation and presentation of data, with particular reference to the high-resolution NMR of hydrogen as used to study the structure of molecules, and the EMR technique as applied to study free radicals.

Mass spectrometry, in essence, deals with the successive process of ion formation, ion separation according to mass, and ion abundance measurement. When applied to analysis the method gives vital information on the chemical and structural nature of a molecule. The various aspects of mass spectrometry and its applications are reviewed in the third article under this title by F. W. Melpolder and R. A. Brown.

The ion-scattering method of chemical analysis has stemmed from the method of nuclear reactions and nuclear scattering. In the latter, as is well known, targets of various elements are bombarded by beams of accelerated charged particles and the scattered particles and radiations are studied in various ways, especially by the use of high-resolution magnetic spectrometers. If the target material is contaminated ever so slightly by chemicals, then the method allows a sensitive microtechnique of detecting some of the atoms present in the contaminant. It will be of interest to point out that the first specific application of this method was in connection with the analysis of the smog of Pasadena and Los Angeles in the nuclear laboratory of the California Institute of Technology in 1949. This analysis of smog revealed the principal constituents to be carbon, oxygen, sulphur, and lead. In the article on this method S. Rubins brings out its merits and limitations, and also presents some of the results so far achieved.

In the Second Section on Electrical Methods, pointed attention may be drawn to two chapters of great value, namely, "Fundamentals of Electrode Processes" by C. N. Reilley and "Introduction to Electrochemical Techniques" by Reilley and R. W. Murray. The first article brings out in a masterly way the fundamental thermodynamic and kinetic principles of electro-

chemistry. In the second article is given an outline of the better-known electrochemical techniques used in analysis and their inter-comparisons based on the theoretical principles discussed in the previous chapter. These techniques include Voltammetry, Potentiometric and Amperometric titrations, Electrodeposition and Coulometry, Polarography, High-frequency titrations, and Dielectric constant methods.

These methods are further dealt with in detail in the succeeding eleven chapters by different authors.

It is unnecessary to emphasize again that the volumes in this series should be in the possession of all scientific libraries attached to research and industry as ready references.

A. S. G.

**Structure and Ultrastructure of Micro-organisms.** By E. M. Brieger. (Academic Press, New York and London), 1963. Pp. 323. Price \$ 10.00.

Whether bacteria have nuclei, chromosomes and mitochondria are problems still being debated. These are analysed in the present volume in the context of the ultrastructure of these organelles in Protozoa and higher organisms. According to the author, the "nucleoids" of bacteria do not answer to the definitions of either nuclei or chromosomes. The absence of a limiting membrane is cited as evidence to show that it does not satisfy the morphological concept of a nucleus. Though Wohlfarth-Bottermann illustrated "spiralized chromosomes in the nucleus" of *Amphidinium elegans* (Photo 22a, p. 62) Kellenberger's "standard technique" revealed a different picture. It is known that fixatives giving good preservation of the cytoplasmic organelles fail to reveal equally acceptable details in the mitotic chromosomes. One wonders why it may not be so in bacteria also judging from the disagreements on the ultrastructure of mitotic chromosomes in higher organisms.

It is stated that the rapid advances in the fields surveyed necessitated at one stage a complete reconstruction of the book. Though published in 1963, it deals mainly with papers which appeared before the year 1958. This is glaring when we come to the ultrastructure of Yeast and the chromosomes of higher organisms. The nucleus has been photographed in living yeast cells and using this as a standard, its ultrastructure has been elucidated. These find

no mention. Instead, an old paper on the subject, which is out of date, forms the basis for discussions. It would appear that there is a selection of the papers for citation and a preference to work carried out in certain regions of the world alone. Printer's devils of varying dimensions irritate the reader especially when they start appearing even from page xi.

If one accepts the above limitations, the book presents a fair appraisal of the problems discussed.

M. K. S.

### Books Received

From: (Asia Publishing House, Ballard Estate, Bombay-1):

*Prestressed Concrete*, Vol. I. By Y. Guyon. Pp. xxxiii + 459. Price Rs. 35.00; Vol. II. Pp. xx + 741. Price Rs. 50.00.

*Concrete, Technology—Vol. I: Properties of Materials*. By D. F. Orchard, 1963. Pp. 358. Price Rs. 24.00. Vol. II *Practice*. By D. F. Orchard, 1963. Pp. 463. Price Rs. 35.00.

*Light Weight Concrete*. By A. Short and W. Kinniburgh, 1963. Pp. xiii + 368. Price Rs. 35.00.

*Chemical Analysis without H<sub>2</sub>S Using Potassium Tri-Thiocarbonate*. By K. N. Johri. Pp. 107. Price Rs. 9.00.

*The Theory of the Electronic Spectra of Organic Molecules*. By J. N. Murrell, 1963. Pp. xiv + 328. Price 55 sh.

From: (Academic Press, 111, Fifth Avenue, New York-3):

*Enzymes in Blood Plasma* (Translated from German by S. Henley). By B. Hess, 1963. Pp. xii + 167. Price \$ 8.00.

*Handbook of Preparative Inorganic Chemistry* (Vol. I, Second Edition). By G. Brauer, 1963. Pp. xxvii + 1002. Price \$ 36.00.

*Survey of Progress in Chemistry* (Vol. I). Edited by A. F. Scott, 1963. Pp. xii + 340. Price 64 sh.

*Progress in Nucleic Acid Research* (Vol. II). Edited by J. N. Davidson and W. E. Cohn, 1963. Pp. xiv + 346. Price \$ 11.00.

*Methods in Computational Physics—Advances in Research and Applications* (Vol. II). Edited by B. Alder, S. Fernbach and M. Rotenberg, 1963. Pp. xi + 271. Price \$ 11.00.

*Solid State Physics* (Vol. XV)—*Advances in Research and Applications*. Edited by F. Seitz and D. Turnbull, 1963. Pp. xvi + 505. Price 118 sh.



## SCIENCE NOTES AND NEWS

### Theoretical and Applied Mechanics—Ninth Congress

The Ninth Congress on Theoretical and Applied Mechanics and Symposium on High Speed Computation Methods and Machines will be held from December 20 to 24, 1964, at the Indian Institute of Technology, Kanpur, India.

Research papers (with three copies of abstracts) on the subjects mentioned below should reach the Secretary by October 1, 1964. Further information may be obtained from the Secretary, Dr. M. K. Jain, Indian Institute of Technology, Kharagpur, India.

(1) Elasticity, Plasticity and Rheology; (2) Fluid Mechanics (Aerodynamics and Hydrodynamics); (3) Mechanics of Solids (Ballistics, Vibration, Friction and Lubrication); (4) Statistical Mechanics, Thermodynamics and Heat Transfer; (5) Mathematics of Physics and statistics; (6) Experimental Techniques; (7) Computation Methods.

### Central Drugs Laboratory, Calcutta

The Central Drugs Laboratory, Calcutta, set up by the Government of India under the Drugs Act is the National Centre for collection, storage and distribution of International Standards and International Reference Preparations of drugs and pharmaceutical substances. The Laboratory has initiated a programme to prepare National Reference Standards for important drugs and pharmaceuticals for which the International Reference Standards are not available in sufficient quantities.

Under this scheme, pure drug samples are obtained from authentic manufacturers and subjected to collaborative assay against International Standards in both commercial and Government laboratories.

National Reference Standards for Digitalis, Insulin, Pituitary (Post Lobe) Powder, Chloramphenicol, and Ascorbic Acid are now ready for distribution free of cost to Analytical and Control Laboratories and Research Institutions interested in drug standardisation.

Request for National Reference Standards and list of Authentic Chemical Substances available at the Central Drugs Laboratory should be addressed to the Director, Central Drugs Laboratory, 3, Kyd Street, Calcutta-16.

### Laser Beam to Fix Range of Satellites

The Radio Research Station at Slough, near London, will shortly be taking part in an experiment on fixing the range of satellites by means of light from a laser. In the experiment, the light beam will be used rather like radar waves, the light being "fired" at the satellite and reflected back. The range of the satellite as it passes across the sky can be measured from the time it takes for the light to return to the receiver and can be fixed by this means more accurately (to within 15 metres) than by any other method.

At the Slough Station, a 60-inch-diameter search-light mirror will be used for transmitting the laser light and receiving the reflection from the satellite, which is fitted with special reflectors. The laser is mounted at the centre of the mirror.

The satellite will be sighted through telescopes, and at the right moment the laser will fire a beam of light at it with a power of four megawatts, the flash lasting 1/400,000,000 second. At a distance of 1,000 kilometres the beam will be about 1 kilometre in diameter.—(*British Information Services*.)

### Automated Flash-Point Testing

Refineries and chemical plants who have been using the Gallenkamp Asda for distillation tests will now welcome the *Autoflash*, a sister apparatus to the Asda which, unattended, carries out closed-cup Pensky-Martens flash-point tests exactly to the methods prescribed in the ASTM and IP specifications.

The flash itself is detected by a probe which responds instantaneously to any sudden change in vapour temperature. On receipt of the flash signal from the probe the test is terminated, leaving the flash point indicated on the digital readout. At the same time a solenoid valve is actuated to allow cooling water to pass round the heating bath in preparation for the next test.

The instrument comprises two units, the Tester and the programmer. The arrangement permits the tester to be used in a fume cupboard with the Programmer on the bench outside, so avoiding fumes in the laboratory and contamination of the control circuits. [Gallen-

kamp, Christopher Street, London E.C. 2, and Martin & Harris (P.) Ltd., Bombay-1.]

### Giant Quantum Oscillations of Acoustic Waves in a Magnetic Field in Metals

A number of experiments in which some geometrical property of the Fermi surface is directly determined, have proven extremely important in the study of the electronic structure of metals and semi-metals. The de Hass-van Alphen effect, which allows one to determine the extremal cross-sectional areas of the Fermi surface normal to the direction of an applied magnetic field, is a classic example.

In a note to *Physical Review Letters*, Quinn, Langenberg and Rodriguez point out the existence and importance of a new effect, giant quantum oscillations in the attenuation of transverse acoustic waves propagated parallel to a dc magnetic field. In this effect are considered the electronic transitions in which  $\Delta n$ , the change in the Landau level quantum number is non-zero. This fact is quite significant; it results in the two oscillatory effects having entirely different periods. The importance of the effect discussed in the paper is that the period of the oscillations can be used to measure the cross-sectional area of the Fermi surface not merely at extrema, but at any plane in  $k$  space normal to the magnetic field.

According to the calculation of the authors, in a pure sample of sodium, the oscillatory attenuation should be observable at 1.6° K. in a magnetic field of 40,000 G with ultrasonic frequencies of the order of a few kilomegacycles per second.—(*Phys. Rev. Letters*, 27 January 1964.)

### Dynamical Instability of Gaseous Masses in General Relativity

The recent radio-astronomical discoveries, pertaining to "quasistellar" objects which have been located as sources of radiation at prodigious rates of energy and over extended periods of time, have revived interest in the century old theory of gravitational collapse of very large gaseous masses.

It is a well-known result of general relativity that a mass  $M$ , under conditions of hydrostatic equilibrium, cannot have a radius  $R$  which is less than a certain lower limit, known as the Schwarzschild limit, given by

$$R > 9/8 (2GM/c^2) = 9/8 R_0$$

where  $G$  is the constant of gravitation,  $c$  is the velocity of light, and  $R_0$  is the "gravitational radius" appropriate to mass  $M$ .

The existence of the Schwarzschild limit has been the subject of much recent discussion in the context of the "quasistellar" radio sources. The question of the stability of gaseous masses as they approach the Schwarzschild limit is one of great physical interest. An examination of the question, in the framework of general relativity, shows that gaseous masses become dynamically unstable (with respect to radial oscillations) well before they reach the Schwarzschild limit.

Professor Chandrasekhar of Yerkes Observatory, Chicago University, has discussed the stability of gaseous masses with respect to purely radial oscillations. The discussion is based on Einstein's field equations for a metric of the form

$$ds^2 = e^\nu (dx^0)^2 - r^2 (d\theta^2 + \sin^2 \theta d\phi^2) - e^\lambda dr^2$$

where  $\nu$  and  $\lambda$  are allowed to be functions of the world time  $x^0$  and the co-ordinate radius  $r$ .

The derived equations governing hydrostatic equilibrium in general relativity, when applied to the case of a homogeneous compressible model of a sphere of uniform energy density, show the limit of stability to be dependent on the values of the ratio of specific heats  $\gamma$ .

For a perfect gas for which  $\gamma = 5/3$ , the theory shows that dynamical instability will intervene before the configuration has contracted 2.12 times its gravitational radius. For quasistellar radio sources  $\gamma$  can be taken as  $4/3$ , and in this case instability with respect to radial pulsations will have set in already when the configuration is many times its gravitational radius. If in the particular case, applicable to these sources, the mass is assumed as  $M = 10^8$  solar masses, calculations give the lower limit of  $R$ , for dynamical stability, to be about 0.16 light-year. It may be noted that this is of the same order as the radii estimated for these objects.

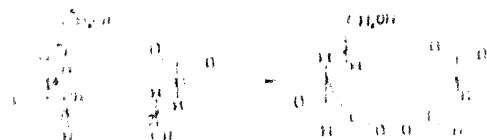
The instability considered is entirely relativistic and according to Chandrasekhar "an unambiguous demonstration, that the instability is manifested in nature when the conditions for its occurrence required by the equation developed here are fulfilled, will provide a unique confirmation for general relativity".—(*Phys. Rev. Letters*, 27 January 1964.)

# SOME OBSERVATIONS ON THE ACIDIC PROPERTIES OF OXYCELLULOSES

G. M. NABAR, V. A. SHENAI AND S. M. MEHRA

Department of Chemical Technology, University of Bombay, Matunga Road, Bombay-19

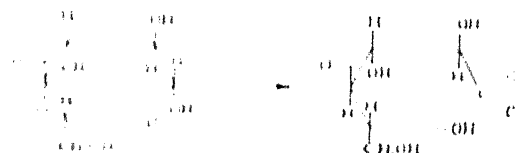
**C**ELLULOSE, being a polyanhydride of glucose pyranose, contains primary and secondary hydroxyl groups in its molecular structure. By virtue of the presence of these atoms, cellulose is amenable to oxidation at these centres with the formation of various oxidation products, commonly referred to as "oxycellulose".<sup>1</sup> Oxycelluloses are characterised by the presence of aldehydic, keto or carboxylic acid groups at different positions of the  $\beta$ -glucose pyranose residue, depending upon the chemical properties of the oxidising agent and the conditions of oxidation. The oxidation potential and the concentration of the oxidant, the pH of the oxidising agent, duration of oxidation, the temperature at which the oxidation is carried out, the presence of accelerator, such as dyer's metallic oxides,<sup>2,3</sup> etc., and certain retarding agencies, such light<sup>4,5</sup> or potassium manganate,<sup>6,7</sup> length affect the course of oxidation. The oxidation of cellulose with different oxidising agents, such as sodium hypochlorite,<sup>8,9</sup> sodium hypobromite,<sup>10,11</sup> potassium permanganate,<sup>12,13,14</sup> potassium dichromate,<sup>15,16,17</sup> potassium meta-periodate,<sup>18,19,20,21,22,23,24</sup> and nitrogen dioxide<sup>25,26,27,28,29</sup> has been studied in detail under various conditions mentioned above by many investigators. In spite of the vast amount of research carried out with different oxidising agents, the exact mode of oxidation of cellulose and the positions of carbon atoms in the  $\beta$ -glucose residue involved in the oxidation, is still obscure except perhaps in the case of a few specific oxidising agents. Thus it is known that when cellulose is oxidised either by nitrogen dioxide (heterogeneous oxidation)<sup>25-29</sup> or by potassium permanganate after dissolving the cellulose in cuprammonium hydroxide solution (homogeneous oxidation<sup>30</sup>), the primary hydroxyl group (carbon atom in 6 position of the pyranose ring) is preferentially oxidised to the carboxyl stage. Periodic acid<sup>31,32,33,34,35</sup> is known to oxidise cellulose at the 2-3 position, leading to the formation of a dialdehyde with the simultaneous scission of 2-3 carbon-carbon bond as shown below:



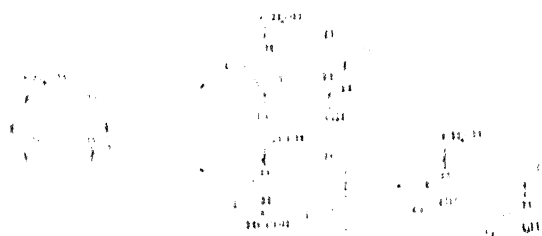
Sodium chlorite under acidic conditions (either with metaphosphoric acid<sup>36</sup> or acetic acid<sup>37</sup>) is a specific reagent for oxidising free aldehyde groups. Thus, when oxycellulose prepared by using potassium meta-periodate is treated with sodium chlorite at a pH of about 3.0 (adjusted with acetic acid), a large proportion of the remaining groups are oxidised to carboxylic acid groups.

With other oxidising agents, however, cellulose may get oxidised in any one or more of the following ways:

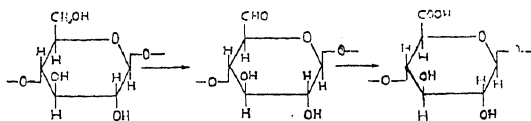
(i) The potential aldehyde group at 1 position of the end  $\beta$ -glucose residue may be oxidised to carboxylic acid, giving a gluconic acid with the simultaneous opening of the six-membered glucose pyranose ring:



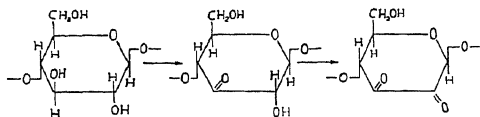
(ii) The additional secondary hydroxyl group at 4 position of the  $\beta$ -glucose residue at the other end of the molecular chain may either be oxidised to a keto group or the ring may be ruptured simultaneously at the 2-3 and 3-4 positions, resulting in the formation of a dialdehyde and formic acid. The dialdehyde may further be oxidised to a dicarboxylic acid:



(iii) The primary alcoholic group in 6-position may first be oxidised to aldehyde group and then to carboxyl, giving a uronic acid type of oxycellulose :



(iv) The secondary hydroxyl groups in 2 and 3 positions may be oxidised in stages giving a mono- or a di-ketone :



(v) Both the secondary hydroxyl groups may be oxidised to aldehyde groups with the simultaneous rupture of carbon-carbon bond, as mentioned earlier. The dialdehyde may further be oxidised to a dicarboxylic acid.

With most of the oxidising agents, it has been generally found<sup>53</sup> that when oxidation of cellulose is carried out under acidic conditions, the resultant oxycellulose exhibits pronounced reducing properties, while that carried out under alkaline conditions gives oxycellulose having marked acidic properties.

The extent of oxidation of cellulose is generally assessed in terms of the oxygen consumed by cellulose on the one hand and by the extent of modification of the chemical nature of cellulose by measuring either its reducing or acidic properties or both, on the other. Generally the reducing properties of oxycelluloses are determined by finding out the amount of cupric copper reduced from an alkaline copper sulphate solution (Braid's solution) by the sample under standard conditions and expressing it as copper number.<sup>54-55</sup> Various methods are available for determining the acidic properties of oxycelluloses. Thus when an oxycellulose is distilled with 12% hydrochloric acid, carbon dioxide is liberated if it contains carboxyl groups in suitable positions. This gas could suitably be absorbed in potash bulbs or in excess of a standard baryta solution and the percentage of such groups in the oxycellulose can be calculated.<sup>56</sup> This method, however, is mainly applicable to uronic acid type of oxycelluloses.

The acidity of an oxycellulose can also be measured in terms of its silver binding capacity.<sup>57</sup> In this method, the sample is treated

with a solution of a silver salt (silver nitrate or silver-*ortho*-nitrophenolate) for a sufficiently long period to attain equilibrium and the loss of silver from the solution is determined by titration.

When an oxycellulose sample is treated with aqueous calcium acetate solution,<sup>57</sup> the hydrogen of the carboxyl group of the oxycellulose is replaced by calcium. From the decrease in calcium ion concentration in the solution the amount of calcium fixed, which is a measure of the carboxyl groups present in the oxycellulose, can be calculated.

The acidity of oxycellulose samples can be directly measured by alkali titration method of Neale and Stringfellow.<sup>58</sup> In the case of oxycellulose containing alkali sensitive reducing groups, this method gives high and fictitious values for the carboxyl content.

Acidic oxycelluloses preferentially absorb basic dyes from their solutions and this property is made use of in estimating their acidic content. Methylene blue is conveniently used for such measurements.<sup>59</sup> The method of estimating methylene blue is elaborate and gives stoichiometric results only under strictly standardised conditions as shown by Davidson.<sup>59</sup>

On the basis of the observations of Lüdtke<sup>60</sup> that iodine is liberated on addition of a solution containing potassium iodide and potassium iodate to a suspension of an oxycellulose in aqueous sodium chloride, Nabar and Padmanabhan<sup>61</sup> developed a method for estimating carboxyl groups in oxycellulose. The iodimetric method is carried out at room temperature and at a pH of about 7. These authors compared their method with both the alkali titration and the methylene blue absorption methods and showed that their method was free from the disadvantages of both. They also claimed that their method is applicable to the determination of carboxylic acid groups in all types of oxycelluloses. The method has been subsequently modified by Achwal, Nabar and Padmanabhan<sup>62</sup> by raising the working temperature to 60° C. in order to reduce the time of reaction.

In order to characterise the nature of the groups formed in cellulose during oxidation with different oxidising agents, treatment of oxycellulose samples with aqueous sodium borohydride is carried out. This reagent has been found to be useful for removing all the reducing groups present in oxycelluloses.<sup>63</sup> Thus the copper number of most of the oxycelluloses can be practically reduced to zero by a treatment

TABLE I

Effect of sodium borohydride treatment on the acidic values of different oxycelluloses

Oxidising agent	pH or duration of oxidation	Acid value (bismetric method) (meq. per 100 g. bone dry sample)			Percentage decrease in acidic value due to borohydride treatment $\frac{(a-b)}{a} \times 100$
		Due to oxidation	Due to oxidation followed by borohydride treatment	Due to borohydride treatment	
		(a)	(b)	(a-b)	
1	2	3	4	5	6
Sodium Hypochlorite	(pH)				
	5.00	0.60	0.33	0.27	45.0
	6.00	4.45	2.60	1.85	41.6
	6.50	6.15	3.40	2.75	44.7
	7.00	7.70	6.10	1.60	20.8
	8.00	3.20	2.80	0.40	12.5
	9.10	1.45	1.30	0.15	10.4
Sodium Hypobromite	(pH)				
	5.88	3.89	2.90	0.90	23.7
	6.50	7.29	6.28	1.01	13.9
	7.50	4.04	3.59	0.45	11.1
	9.00	15.46	14.28	1.18	7.6
	10.10	23.97	22.95	1.02	4.3
	11.00	19.71	18.71	1.01	5.1
Potassium permanganate	(pH)				
	5.10	5.82	4.83	0.99	12.5
	6.10	3.82	3.23	0.59	17.6
	6.90	4.23	4.14	0.09	12.5
	7.80	5.75	4.60	0.75	14.0
	9.20	10.69	9.29	0.80	7.9
Sodium hypochlorite in presence of leuco vat dyes present on fibres	(pH)				
	4.89	0.65	0.40	0.25	38.5
	6.42	1.70	0.89	0.81	47.7
	7.00	1.10	0.69	0.50	45.5
	7.00	2.31	1.54	0.77	34.3
	7.00	1.35	0.87	0.48	35.8
	7.33	2.62	1.99	0.63	24.0
	11.00	2.75	2.55	0.20	7.3
	11.00	3.11	2.91	0.20	6.4
Potassium metaperiodate	(pH)				
	4.00	0.57	0.00	0.57	100
	8.00	1.41	0.00	1.41	100
	16.00	2.73	0.00	2.73	100
	24.00	3.04	0.00	3.04	100
	48.00	3.53	0.00	3.53	100
Potassium dichromate + Sulphuric acid	(pH)				
	4	1.06	0.71	0.35	33.0
	8	1.86	1.29	0.57	30.7
	16	4.38	3.16	0.92	21.0
	16-16	3.60	2.89	0.71	19.7
	24	6.44	5.18	1.26	19.6
	24-33	5.30	4.32	0.98	18.5
	48	8.71	7.42	1.29	14.8
Vol. of $K_2Cr_2O_7$ Solution (ml)					
Potassium dichromate + Oxalic acid	10	0.20	0.10	0.10	50.00
	20	1.31	0.92	0.39	29.8
	40	2.04	1.50	0.54	26.5
	60	2.72	2.12	0.60	22.1
	75	2.87	2.35	0.52	18.1
	80	3.72	3.14	0.58	15.6
	100	6.50	5.50	1.00	15.4

with an aqueous solution of sodium borohydride. Such unbuffered solutions of sodium borohydride do not reduce carboxyl groups.<sup>64</sup> However, during the present investigation it was found that the various oxycellulose samples, after treatment with sodium borohydride showed a definite and measurable decrease in the acid value as determined iodimetrically. These observations are shown in Table I. It will be seen that the reduction in the carboxyl value after borohydride treatment varies from 100% for some oxycelluloses to about 6% for others.

Since unbuffered sodium borohydride solution does not reduce carboxyl groups, the decrease in the acid value of oxycelluloses after borohydride treatment, is likely to be due to the presence of other groups which are not carboxyl groups but which behave in a manner similar to carboxyl groups towards iodide-iodate mixture and liberate free iodine. A reference has been already made to the existence of such groups in oxycelluloses by Nabar and Shenai.<sup>9</sup>

It was therefore decided to examine if this behaviour of oxycelluloses after treatment with borohydride is confirmed by using some other method for estimating carboxyl groups in oxycelluloses. The methylene blue absorption method<sup>59</sup> was selected for this purpose. Several oxycellulose samples, prepared using different oxidising agents, were examined for their carboxyl content by methylene blue absorption method before and after borohydride treatment.<sup>63</sup> The results are given in Table II.

It is seen that practically no decrease takes place in the values of methylene blue absorption obtained before and after borohydride treatment. From this it is confirmed that the iodimetric method of Nabar and Padmanabhan<sup>61</sup> not only measures true carboxyl groups but other acidic groups (pseudo carboxyl groups) which are formed side by side during oxidation and which also liberate iodine during the iodimetric estimation.

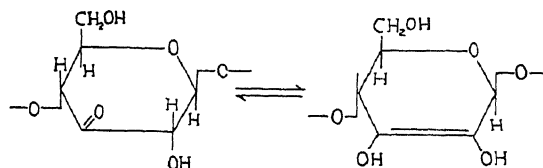
The results given in Table I indicate that borohydride treatment reduces these pseudo carboxyl groups. After treatment of the oxycelluloses with borohydride, the liberation of iodine from the iodide-iodate mixture is restricted to carboxyl groups alone and therefore a decrease in the acid value is observed. In the case of methylene blue method, however, it appears that only true carboxyl groups and not all the acidic groups are estimated as seen from the results in Table II. In this respect, the iodimetric method is superior in that it estimates the total acidity of an oxycellulose,

TABLE II

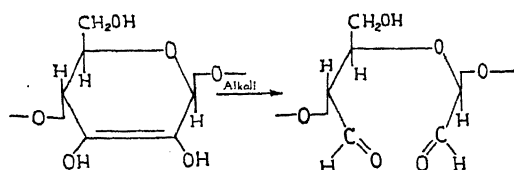
*Effect of borohydride treatment on the carboxyl value of differently prepared oxycelluloses determined by methylene blue absorption method*

Oxidising agent	Carboxyl value (m.eq. per 100 g. bone dry sample)		
	Before borohydride treatment	After borohydride treatment	Decrease due to borohydride treatment
Sodium hypochlorite	1.56	1.44	0.12
	4.22	4.16	0.06
	7.53	7.28	0.25
	4.38	4.38	0.00
	2.55	2.50	0.05
Potassium dichromate	1.80	1.78	0.02
+	3.45	3.19	0.26
Oxalic acid	4.50	4.31	0.19
	5.50	5.50	0.00
	7.69	7.69	0.00
Potassium dichromate	1.78	1.71	0.07
+	2.66	2.47	0.19
Sulphuric acid	5.03	4.94	0.09
	7.22	7.13	0.09
	12.94	12.81	0.13

With a view to find out the nature of the pseudo carboxyl groups formed, an examination of the various probable modes of cellulose oxidation mentioned earlier was undertaken. Since the liberation of iodine from the iodide-iodate mixture would necessarily require the presence of hydrogen ions, it was felt that only the presence of a monoketo derivative in addition to carboxyl groups in the oxycellulose could satisfy this condition. Such a group, if formed, may be present in equilibrium according to conditions either as a monoketo or an enediol form as shown below:



If such groups are formed during oxidation of cellulose, these will be estimated as reducing groups during copper number estimation due to action of the strongly alkaline conditions prevailing therein, resulting in the rupture of the double bond thereby forming a dialdehyde as shown below:



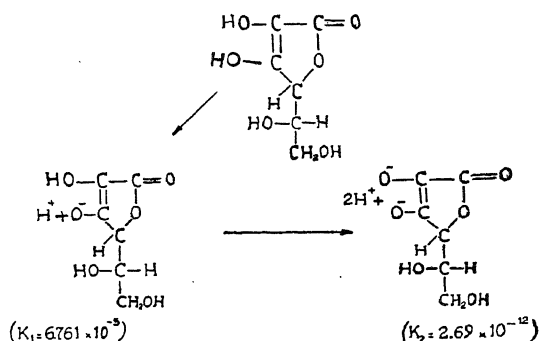
It is of interest to mention here that treatment of almost all oxycelluloses with sodium borohydride brings down the copper number to the level of that of standard cellulose, but even after repeated treatments<sup>40</sup> with chlorous acid,<sup>51</sup> a measurable amount of copper number still persists. It is likely that the residual copper number is due to the presence of enediol groups, present in all oxycelluloses and which are not amenable to oxidation by chlorous acid, but which can be removed by sodium borohydride by reduction.

The enediol groups could provide hydrogen ions to liberate iodine from the iodide-iodate mixture used in the iodimetric method and hence would contribute to the total carboxyl value obtained. However, when these groups are reduced by sodium borohydride as mentioned above, the resulting hydroxyl groups will not liberate iodine. This explains the decrease in carboxyl value (as determined by iodimetric method) observed after treating the oxycellulose with sodium borohydride.

With a view to find some evidence to substantiate the above hypothesis and to establish the formation of enediol groups in cellulose during oxidation with most of the oxidising agents, it was decided to select a known compound containing an enediol group.

One of the best-known examples of such a compound is *l*-ascorbic acid. The acidity of ascorbic acid is due not to a carboxyl group but to the presence of an enediol group.<sup>65</sup> The dissociation constants of this dibasic acid are  $K_1 = 6.761 \times 10^{-5}$  and  $K_2 = 2.69 \times 10^{-12}$ . When  $K_1$  is compared with the dissociation constant of acetic acid ( $K = 1.75 \times 10^{-5}$ ), it is seen that the former is nearly four times stronger than the latter. The ionisation of ascorbic acid is represented below (see structure in next column).

A qualitative examination showed that *l*-ascorbic acid liberated iodine when treated with a solution of  $KI + KIO_3$ . To study the liberation of iodine quantitatively a known weight of the acid was dissolved in carbon dioxide-free distilled water and treated at room temperature with a mixture of  $KI + KIO_3 + NaCl + Na_2S_2O_3$  under standard conditions similar to those followed for the determination



of carboxyl groups in oxycellulose samples<sup>61</sup> and the amount of the acid in solution was estimated on the basis of its dibasicity. The experimentally estimated amounts are compared with the original weight taken for estimation.

The results are given in Table III.

TABLE III  
Estimation of *l*-ascorbic and (B.P.) by iodimetry

Expt. No.	Weight of <i>l</i> -ascorbic acid solution taken (g)	Volume of 0.01655 N $Na_2S_2O_3$ summed by the liberated iodine (ml)	Weight of <i>l</i> -ascorbic acid as calculated from the value given in previous column (g)
1	0.10	67.20	0.098
2	0.10	67.50	0.098
3	0.10	67.70	0.099

It is seen that there is a close agreement between the amount of *l*-ascorbic acid taken and the amount of the same determined by iodimetric method. This confirms that enediol groups liberate iodine from the iodide-iodate mixture quantitatively. The iodimetric method could be employed for estimating quantitatively *l*-ascorbic acid or compounds containing enediol groups.

Thus it appears that the pseudo carboxyl groups mentioned earlier are enediol groups.

From the foregoing discussion and the results given in Table I the following observations can be made:

(1) In the case of oxidation of cellulose with sodium hypochlorite, sodium hypobromite, potassium permanganate and that in presence of leucovat dyes with sodium hypochlorite, the pH of the oxidising solution appears to exert a pronounced effect on the relative proportions of carboxyl groups and enediol groups formed. It is also seen that less and less of true carboxyl groups are formed during the oxidation when carried out

under increasing acidity while more and more of such groups are formed under increasing alkalinity. This is in agreement with the observation that generally acidic oxidation leads to the formation of reducing type of oxycellulose and alkaline oxidation, to acidic type. It is further observed that in the case of sodium hypochlorite more of enediol groups are formed during oxidation of cellulose at pH values lower than 7 as compared to the oxidation carried out at pH values higher than 7.

(2) When the oxidation of cellulose is carried out by using potassium dichromate with either sulphuric acid or oxalic acid, it appears that as the extent of oxidation increases (either as a result of increasing the duration of oxidation or of increasing the amount of the oxidant) relatively more and more true carboxyl groups are formed. This can be seen from a comparison of the percentage decrease in acid values after borohydride treatment of these oxycelluloses in the earlier and later stages of oxidation.

(3) when the acid values of potassium meta-periodate oxycelluloses and of those treated with sodium borohydride are examined, it is seen that borohydride treatment removes all the apparent acidity, thereby suggesting that no true carboxyl groups are formed during the oxidation. Since this oxidising agent is specific in nature and attacks only at 2:3 position of the  $\beta$ -glucose units of cellulose (and also at 3:4 position of one of the end units), the possibility of the formation of enediol groups at this position cannot be ruled out. In this connection, it is interesting to note that when acid values of this oxycellulose are determined by methylene blue absorption method, it is found that these values are not different from that of unoxidised cellulose. Methylene blue absorption values of five oxycellulose samples prepared by oxidising cellulose with potassium meta-periodate for different periods were found to be 1.13, 1.22, 1.13, 1.22 and that of unoxidised standard cellulose was 1.22 m.mol. of Methylene Blue per 100 g. of bone dry sample.

The formation of enediol groups during oxidation of cellulose has been referred to by Kenyon *et al.*<sup>45-46</sup> and by Nabar and Padmanabhan<sup>49</sup> with respect to nitrogen dioxide oxycellulose. It appears that when cellulose is oxidised, in addition to aldehyde and carboxylic acid groups, enediol groups are also formed simultaneously and that these are formed in a

definite proportion to the carboxylic and aldehyde groups. Further investigations on these lines are in progress.

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## LABORATORY TRANSMISSION OF AN INDIAN STRAIN OF CHIKUNGUNYA VIRUS

T. RAMACHANDRA RAO, K. R. P. MENGH AND KHORSHID M. PAVRI

*Virus Research Centre, Poona, India*

CHIKUNGUNYA virus, a group A arthropod-borne virus, was first discovered in 1946-47 in Tanganyika,<sup>1,2</sup> where it was found to produce a dengue-like illness in man. Subsequently it has been detected in other places including South-East Asia, e.g., Thailand.<sup>3,4</sup>

The virus has been isolated in nature from the following wild-caught mosquitoes:

*Aedes aegypti*: Tanganyika,<sup>1,2</sup> Bangkok, Thailand.<sup>5</sup>

*Aedes africanus*: Uganda.<sup>6</sup>

*Culex fatigans*: Tanganyika,<sup>1,2</sup> Bangkok, Thailand.<sup>4</sup>

*Mansonia* spp.: Uganda.<sup>6</sup>

There is a solitary report of an isolation from *Cimer hemiptera* (Bed bugs) in Tanganyika.<sup>7</sup>

Laboratory transmission of the virus has been obtained through *Aedes aegypti* and *Aedes albopictus*.<sup>11</sup>

Recently Chikungunya virus has been isolated from human cases in Calcutta. Pending intensified attempts at isolation of the virus from wild caught arthropods, it was thought necessary to make preliminary laboratory studies on transmission with species of mosquitoes which are common in the city. The present report deals with such laboratory transmission studies with an Indian strain of the virus isolated from serum obtained by Dr. S. P. Aikat from a case of human febrile illness in Calcutta (virus strain No. VRC/634029).

Eight series of experiments were done at the Virus Research Centre, Poona, using laboratory-bred *Aedes aegypti*, *Aedes albopictus*, *Anopheles stephensi* and *Culex fatigans*, all of Indian origin. All these species are known to be widely prevalent in the city. In all the experiments two to three day old infant mice (*Swiss albino*) were inoculated intracerebrally (i.c.) with 0.02 c.c. of the virus suspension (approximately 10<sup>6</sup> to 10<sup>7</sup> mouse I.D.<sub>50</sub>). The virus used in these

\* The Virus Research Centre is jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation.

TABLE I

Infection of mosquitoes with the Indian strain of Chikungunya virus and its transmission by bite to infant mice

Species of mosquito	Presence of virus in mosquitoes soon after feeding on infected infant mice	Presence of virus in mosquitoes after 10 days of incubation and refeeding on infant mice	Transmission of virus by bite of mosquitoes to infant mice
<i>Aedes aegypti</i>	.. 8/8*	24/24	20/24
<i>Aedes albopictus</i>	.. 6/6	24/24	11/21
<i>Anopheles stephensi</i>	.. 10/10	8/23	0/23
<i>Culex fatigans</i>	.. 5/5	0/23	0/23

\* Numerators are the number of mosquitoes positive for Chikungunya virus; denominators are the number tested.

experiments was at the first to third mouse passage level. On the second post-inoculation day, starved mosquitoes were allowed to feed on the infected mice. No titrations of the virus in the blood of the infected mice were made but soon after engorgement, a sample of the fed mosquitoes was ground and tested for the presence of virus by i.c., inoculation of infant mice; the remaining mosquitoes were maintained in bobbinet cages at 85°-90° F. and 80% relative humidity for periods ranging from 10 to 15 days. The mosquitoes were fed on raisins and glucose during the period of holding.

Ten days after the infective feeding, a number of mosquitoes were allowed to feed on two to three-day old infant mice to test for the ability of the various mosquito species to transmit Chikungunya virus. All these mosquitoes were tested for the presence of virus immediately after engorging. In a few cases a similar attempt of transmission was made on the 15th day. Detection of the virus was made by inoculating the material in baby mice and identity confirmed as Chikungunya by complement fixation tests.

The results of all the experiments have been pooled and summarized in Table I. It may be seen that with *Aedes aegypti* all the eight mosquitoes tested immediately after feeding were found to have engorged the virus and all 24 tested after ten days had retained the virus. Twenty out of 24 mosquitoes were also able to transmit the virus to baby mice. *Aedes albopictus* yielded similar results though the transmission rate was slightly lower. *Anopheles stephensi* and *Culex fatigans* successfully picked up the virus by feeding but neither transmitted the virus to baby mice after ten days. While some *Anopheles stephensi* (eight out of 23) were found to retain the virus for ten days,

no virus was demonstrated in any of the 23 *Culex fatigans* tested ten days after the infectious feed. In an experiment where *Aedes aegypti* were kept for 15 days, all the eight mosquitoes tested had retained the virus and three out of five transmitted the virus to baby mice. In a similar experiment with *Aedes albopictus*, all four mosquitoes kept for 15 days transmitted the virus. It would be interesting to test in further experiments whether *Anopheles stephensi*, which has now been found to retain the virus for ten days but does not transmit it, would transmit the virus if held for a longer period.

These preliminary studies show that:

(1) The Indian strains of *Aedes aegypti* and *Aedes albopictus* can transmit Chikungunya virus;

(2) *Culex fatigans* and *Anopheles stephensi* perhaps have little or no importance as vectors.

Further studies are in progress and will be reported later.

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## SENSORY PHYSIOLOGY OF THE ANAL LEGS OF CENTIPEDES

B. S. JANGI

Department of Zoology, College of Science, Nagpur

**L**EGS of the posteriormost pair in centipedes of the order Scolopendromorpha are the largest of the segmental appendages and are usually referred to as anal legs on account of their close proximity to the anal region. During locomotion, these appendages are kept lifted up from the ground in an extended position. The skeleto-muscular mechanism of their leg-base is such as renders them unfit for propulsive role during walking.<sup>1</sup> No information has appeared in the literature concerning the function of these organs. A neurophysiological analysis was, therefore, attempted with a view to determining whether, like the antennae at the anterior end, the anal legs are concerned with the perception of stimuli at the other end of the body.

The material on which this report is based, consisted of the American centipede *Scolopocryptops verspinosus* (Say). The last leg-bearing segment, together with the anal leg, was isolated from the body and putted on a wax-platform in such a manner as would keep the legs freely suspended in the air (Fig. 1, A). The crural nerve which happens to be the only one supplying the anal leg was exposed and then severed near its union with the trunk ganglion in order to eliminate motor activity from any recording from this nerve. Since nothing has been published on the neurophysiology of centipedes, a quest had to be made for a suitable medium in which the centipede nerve preparations could be kept alive. Salines, generally used in electrophysiological work on insects, were tried. To one of them (Pringle's), the centipede material in hand responded favourably. The action potentials were recorded monophasically on a single, fine tapered, pick-up silver electrode placed below the nerve (Fig. 1, B), an indifferent silver electrode being in saline. Electrical activity in the nerve was amplified with P4 Grass amplifier and observed on a Dumont 304 A cathode ray oscilloscope. It was monitored with a loud-speaker and recorded by means of a Grass kymograph camera. A regular sequence of spikes could be seen even though no stimulus was applied (Fig. 1, E). This could perhaps be spontaneous sensory activity. To simulate the actual posture of an anal leg during normal locomotion of the animal,

a tapering hooked glass rod was used for lifting the appendage, thus bringing about its elevation and extension simultaneously. This resulted into a well marked increase in the nerve activity (Fig. 1, F) indicating thereby that some mechanoreceptors were stimulated during this movement. The increased nerve activity could be, with reasonable accuracy, attributed to the hair sensilla situated dorsally on the femur (Fig. 1, C) and the succeeding leg segments near the hinge articulations, since these are the only known receptors which, by virtue of their anatomical situation, could be physically displaced and thus mechanically stimulated by being pressed on the arthrodistal membrane which permits dorsally the telescoping of the proximal part of a segment into the distal part of the preceding one during the extension-elevation movement of the leg (Fig. 1, D). These sensilla are served by fine nerve fibres which ultimately end their way into the main crural nerve joining the penultimate trunk ganglion.

The anal legs bear also other receptor organs which appear to be unconcerned with mechanoreception; their structure and function are still under investigation. Nevertheless, it seems reasonably certain that these appendages, like the antennae, are sensory feelers. This is quite in harmony with our knowledge of the ecology and behaviour of centipedes. Basically these animals shun light and are adapted to live in darkness under cover. Several of them are destitute of eyes, and those which possess them are hardly able to see beyond distinguishing between light and darkness.<sup>2</sup> It is not surprising, therefore, that the long, myriapodous, fast running and actively hunting animal like the centipede, capable of backward locomotion has, through structural modification, released its last pair of legs from locomotory responsibility to the reception of various stimuli in the immediate vicinity of its caudal end. Their performance as efficient feelers is further rendered possible by the ability of the animal to maintain a correct posture for these appendages by keeping them lifted up throughout during locomotion presumably through a feedback system involving the aforementioned mechanoreceptors, the central nervous system and the extensor and levator muscles concerned.

This investigation was carried on in the Department of Biology at Tufts University, Medford, Massachusetts, during leave of absence to participate in the International Education

Nancy S. Milburn for help and encouragement. My thanks are due to my friend Dr. V. G. Kher, Professor of Physics, Vidarbha Mahavidyalaya, Amravati, for kindly reading the manuscript.

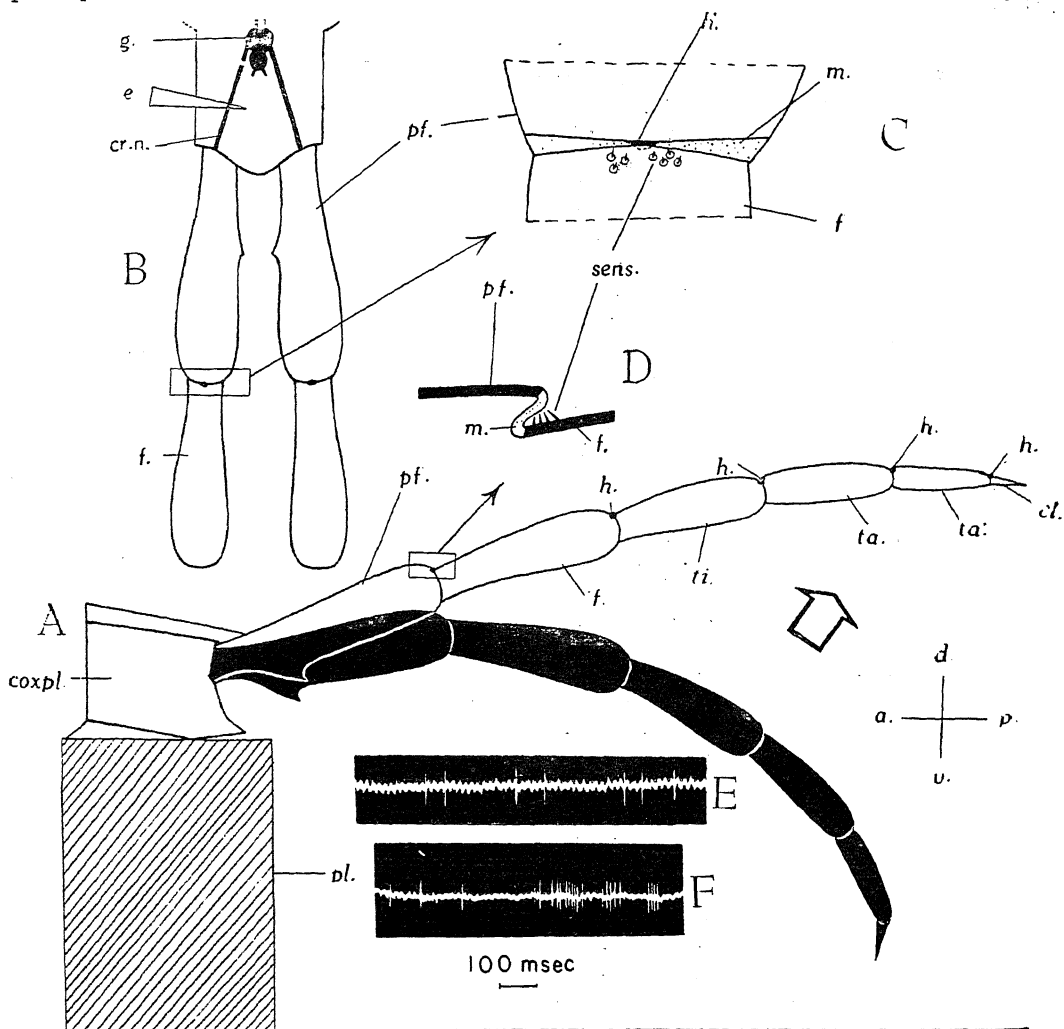


FIG. 1. A. Caudal region (in side view) of *Scolopocryptops* mounted on wax-platform showing the left anal leg in two positions: (1) when suspended (drawn black), and (2) when lifted up and extended; B. Nerve supply of anal legs, and position of the pick-up electrode in relation to crural nerve; C. Prefemoro-femoral junction in dorsal view showing the hinge joint and associated sensillae; D. Longitudinal section near this joint showing hair sensillae pressed on the arthrodial membrane when femur is telescoped into prefemur dorsally during levation and extension of anal leg; E. Afferent activity in crural nerve when the leg is in a suspended position; F. Afferent activity after the leg is lifted up and extended. a., anterior; cl., claw; coxpl., coxopleuron of the last leg-bearing segment; cr. n., crural nerve; d., dorsal; e., pick-up electrode; f., femur; g., last but one trunk ganglion; h., dorsal hinge joint; h', prefemoro-femoral hinge joint; m., arthrodial membrane; p., posterior; pf., prefemur; pl., wax-platform; sens., hair sensillae; ta. and ta', tarsal segments; ti., tibia; v., ventral.

Exchange Programme of the U.S. Department of State as a Fulbright and U.S. Public Health Service Post-doctoral Fellow. I am indebted to Professor K. D. Roeder and Drs. C. C. Roys and

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## LETTERS TO THE EDITOR

### INFLUENCE OF INCOHERENT SCATTERING ON THE POLARISATION OF ELASTIC SCATTERING OF GAMMA RAYS

The polarisation of the elastic scattering of 0.411, 0.662 and 1.25 MeV gamma rays from lead at  $90^\circ$  was first measured by Sood<sup>1</sup> to investigate the variation of polarisation with gamma-ray energy. His results showing marked decrease in polarisation with energy agree with the predictions of refined calculations for Rayleigh scattering<sup>2</sup> but contradict strongly the predictions of form factor calculations<sup>3,4</sup> that give cent per cent. polarisation irrespective of energy. The experimental values of polarisation are however lower than those given by refined calculations. Later Mammio and Vitale<sup>5</sup> measured the polarisation of the elastic scattering of 1.25 MeV gamma rays from lead at  $40^\circ, 60^\circ, 75^\circ, 90^\circ$  and  $105^\circ$ . Their values are again lower than the theoretical values and the possible reason for this difference has been attributed to the contribution of L-shell electrons for which exact calculations are not available. The refined calculations are only for the scattering from K-electrons in Hg. We have performed some experiments to investigate the reasons for this discrepancy and find that incomplete isolation of elastic scattering from inelastic scattering lowers the experimental values and L-shell electron effects, if any, are comparatively small. The experiments and the results obtained are outlined below. The details have been omitted and shall be published separately. The measurements were made with 662 keV gamma-rays scattered from lead at  $64^\circ$  because of the following reasons:

(i) Our previous scattering experiments<sup>6</sup> at this energy and angle show that it is not difficult to analyze the scattered spectrum and get a good estimate of the contributions of elastic and inelastic scattering.

(ii) By the choice of suitable filters in front of the detector the relative contributions of elastic and inelastic scattering to the observed scattered spectrum can be varied. With a lead filter of  $24 \text{ gm./cm}^2$  the contribution of inelastic scattering to the observed spectrum in the region above 640 keV is negligible. Therefore in this energy region of scattered spectrum almost

complete isolation of elastic scattering from inelastic scattering is possible.

(iii) The theoretical value of polarisation (91%) is fairly large and it should be easy to measure it.

The first experiment was designed to check the correctness of the method used by Mammio and Vitale to account for the contribution of inelastic scattering. Their method consisted of using a compensation scatterer of Al having same number of electrons as the experimental lead scatterer so as to give same Compton scattering and taking the scattering for Al as the contribution of inelastic scattering. We compared the spectra of radiation scattered from Pb and Al scatterers in the region extending from 590 keV (Compton energy) to 680 keV (maximum energy of bound electron scattering) and found the two to differ by 30%. This shows that this method of estimating the contribution of inelastic scattering is in error. Manning and Jovanovitch<sup>7</sup> have also pointed out the drawbacks of this method and found the error sections measured by using this method to be in error by a factor of two at gamma-ray energy of 1.33 MeV.

The polarisation of scattering above 640 keV was then analyzed by using  $24 \text{ gm./cm}^2$  of lead filter in front of the detector. The use of such thick filter reduced the counting rate considerably and 200 hours running was needed to get the result of  $96 \pm 6\%$  which agrees with the theoretical value of 91%. The agreement between experiment and theory shows that the previous experimental values are lower because of incomplete elimination of incoherent scattering.

The thickness of lead filters was then reduced to  $8 \text{ gm./cm}^2$  and zero  $\text{gm./cm}^2$  to get the ratio of elastic to inelastic scattering within the experimental channels at  $1:1.3$  and  $1:3$  respectively and the polarisation measured. The values of  $66 \pm 5\%$  and  $54 \pm 4\%$  were obtained which shows that the contribution of inelastic scattering lowers the polarisation of elastic scattering.

Knowing the contribution of incoherent scattering in the experimental channels, the experimental values can be corrected for the contribution of incoherent scattering provided its polarisation within the same channels is

known. In an effort to make this correction, the polarisation of inelastic scattering was measured within the energy region 470 to 550 keV. to be  $45 \pm 3\%$ . The experimental values when corrected for the known contributions of incoherent scattering come out to be  $94 \pm 10\%$  and  $88 \pm 10\%$  respectively.

From the above investigations it may be concluded that incomplete elimination of incoherent scattering tends to lower the experimental values of the polarisation of elastic scattering of gamma-rays and the effects of L-shell electrons, if any, are comparatively small.

Physics Department,  
Panjab University,  
Chandigarh-3, February 24, 1964. B. S. Sood.

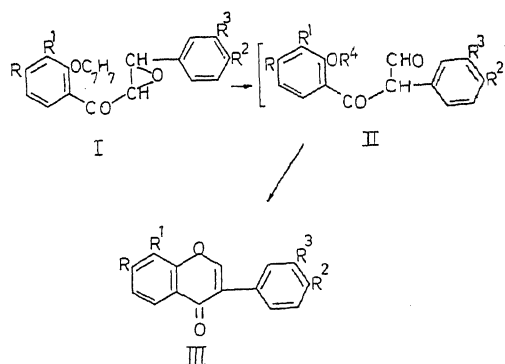
M. SINGH.  
S. ANAND.

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#### SCOPE OF ISOFLAVONE SYNTHESIS USING 2'-BENZYLOXYCHALKONE EPOXIDES

In a previous communication,<sup>1</sup> the conversion of two polysubstituted 2'-benzyloxychalkone epoxides into corresponding isoflavones, formononetin and  $\psi$ -baptigenin in two stages was reported, the first consisting of rearrangement to  $\alpha$ -formyl desoxybenzoin with boron trifluoride etherate and the second of debenzylative cyclisation using either catalytic hydrogenation or a mixture of hydrochloric acid and acetic acid. In a later publication,<sup>2</sup> boron trifluoride etherate was reported not to bring about rearrangement with simple 2'-benzyloxychalkone epoxide and its 4'-methyl ether but to yield corresponding dihydroflavonols (see ref. 3 also). Hence it was considered necessary to examine the scope of this method for the synthesis of isoflavones. A study of the action of boron trifluoride etherate on various 2'-benzyloxychalkone epoxides has now revealed that either of these reactions takes place depending on substituents. Such chalkone epoxides as having no substituents in the styryl part give only dihydroflavonols; whereas those which have

at least p-methoxyl in the styryl part give a mixture of 2-hydroxy- $\alpha$ -formyl desoxybenzoin (II,  $R^4 = H$ ), 2-benzyloxy- $\alpha$ -formyl desoxybenzoin (II,  $R^4 = C_6H_5$ ) and the corresponding isoflavone (III). The desoxybenzoins can be separated from the isoflavone by extraction with aqueous sodium hydroxide. The 2-hydroxydesoxybenzoin (II,  $R^4 = H$ ) undergoes ready cyclisation on acidification of the alkaline solution; whereas the 2-benzyloxydesoxybenzoin (II,  $R^4 = C_6H_5$ ) can be converted into isoflavone (III) by heating with a mixture of



For I, II, III, <sup>3</sup>  
a,  $R = R^2 = H$ ;  $R^4 = OCH_3$   
b,  $R = R^2 = OCH_3$ ;  $R^4 = H$   
c,  $R = H$ ;  $R^2 = R^4 = OCH_3$

hydrochloric acid and acetic acid. The total yield of the isoflavone is good as reported earlier.<sup>1</sup> Thus 4'-methoxy isoflavone (III a) has been prepared for the first time, and also the naturally occurring isoflavone cabreuvin<sup>4</sup> (III b) and 7,8,3',4'-tetramethoxyisoflavone (III c) which is related to maxima isoflavone-A<sup>5</sup> have been obtained in good yields. It may be remarked that among acidic reagents<sup>2</sup> known to bring about rearrangement, boron trifluoride etherate works most satisfactorily but only for such isoflavones as have at least a 4'-methoxy.

Department of Chemistry, S. C. BHARRA.  
University of Delhi, A. C. JAIN.  
Delhi-6, February 27, 1964. T. R. SESHADRI.

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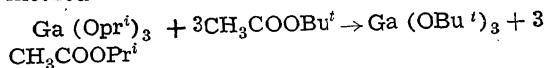
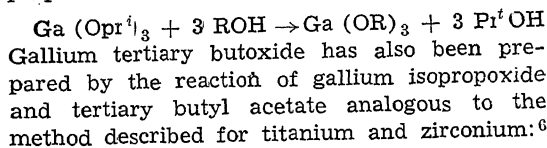
## GALLIUM ALKOXIDES

THE preparation of alkoxides of lanthanide elements by the reaction of anhydrous metal chloride and sodium isopropoxide has been recently reported from these laboratories.<sup>1</sup> Amongst the elements of the group, alkoxides of boron<sup>2</sup> and aluminium<sup>3</sup> have received considerable attention, but a survey of the literature reveals that no systematic study has been done so far, for preparation of gallium alkoxides. It was, therefore, considered of interest to prepare these by reactions similar to those described for lanthanides,<sup>1</sup> thorium<sup>4</sup> and germanium.<sup>5</sup>

Gallium isopropoxide has been prepared by adding stoichiometric quantity of sodium isopropoxide to a solution of gallium trichloride in anhydrous benzene and refluxing the mixture for 6-8 hours:



The isopropoxide distils at 136°/2.0 m.m. and solidifies on being kept for a few days into a crystalline solid soluble in organic solvents, but very highly susceptible to moisture. Gallium isopropoxide has been found to be a convenient starting material for the preparation of other alkoxides; thus, gallium tertiary butoxide (a colourless fuming liquid, b.p. 137°/1.0 m.m.) and methoxide (white crystalline solid insoluble in organic solvents) have been prepared by the alcohol interchange reactions between the isopropoxide and the corresponding alcohols:



The reaction of gallium isopropoxide with excess of acetyl chloride has been found to be highly exothermic and gives immediately a dark-red viscous liquid the analysis corresponding to  $\text{GaCl}_3\text{CH}_3\text{COOPr}^i$ . Similarly the reaction of anhydrous hydrogen chloride on gallium isopropoxide in benzene gave a light-red coloured liquid,  $\text{GaCl}_3\text{Pr}^i\text{OH}$ . These reactions are of interest in view of the observed reactivity of alkoxides of aluminium,<sup>7</sup> titanium<sup>8</sup> and germanium<sup>9</sup> with hydrogen halides.

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## THE LOGARITHMIC ORDER OF THE PLANETS AND THEIR SATELLITES

In an article under the above title Frank Allen<sup>1</sup> has given astronomical data and graphs to show that a logarithmic equation,

$$\log P = K \log D + C$$

can represent the relationship between the period of revolution P and distance D from the Sun of all planets from Mercury to Pluto. It is the purpose of this note to show that the above logarithmic equation can be easily derived by considering the forces governing the motion of the planet.

The forces acting on the planet of mass m, moving with velocity V, in an approximately circular orbit of radius D are the centrifugal force  $mV^2/D$  and the force of gravitation  $G M m/D^2$  where M is the mass of the Sun and G the gravitation constant. As the forces balance,

$$mV^2/D = G M m/D^2 \quad \dots \dots \dots (1)$$

$$\text{Now } V = 2\pi D/P$$

$$\text{Hence } P^2 = (4\pi^2/GM) D^3 = ED^3$$

where E is a constant for the solar system.

Taking logarithms and dividing by 2,

$$\log P = 3/2 \log D + 1/2 \log E$$

$$= -K_1 \log D + C_1,$$

where K and C are constants whose values depend on the units chosen for distance and time.

Allen has also shown that the same logarithmic equation applies to velocity and distance. This result also follows from equation (1).

$$V^2 D = GM$$

$$\text{Hence } \log V = -1/2 \log D + 1/2 \log (GM) - K_1 \log D + C,$$

where  $K_1$  and  $C_1$  are constants.

The negative sign preceding the constant  $K_1$  supports Allen's observation that the graph representing  $\log V$  and  $\log D$  has negative slope.

Thus his conclusion that the force of gravity imposes an exact logarithmic relationship between the periods, velocities and distances from the centres of revolution of all the planets and their satellites verifies the established laws of planetary motion.

Physics Department, G. M. SREEKANTH.  
P.S.G. College of Technology,  
Coimbatore-4, February 12, 1964.

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### A MODIFIED EDTA METHOD FOR DETERMINATION OF SOLUBLE SULPHATES IN SOILS AND WATERS

THE gravimetric method (Piper, 1947) was the most widely used method for the determination of soluble sulphates but now the EDTA method recently proposed by Jackson (1958) is usually followed. It involves chelation of excess of  $\text{Ba}^{++}$  left after  $\text{BaSO}_4$  precipitation. The method is more rapid and gives good results with even low concentration of sulphates, but  $\text{Ca}^{++}$ ,  $\text{Ca}^{++} + \text{Mg}^{++}$  and excess of  $\text{Ba}^{++}$  are determined in separate aliquots which need a large amount of sample and time for these estimations. To save time, quantity of versenate used and to estimate all the above ions in a small soil or water aliquots, an attempt is made to modify this method.

In this modified method  $\text{Ca}^{++}$  was determined with ammonium purpurate indicator. The end point was decolorised with few drops of HCl, and  $\text{Mg}^{++}$  estimated using  $\text{NH}_4\text{Cl} + \text{NH}_4\text{OH}$  buffer and erichrome black-T as an indicator. The end point of  $\text{Mg}^{++}$  determination was decolorised with few drops of concentrated bromine water and few drops of HCl were added to make the solution acidic. Barium chloride of known strength was added and after precipitation of  $\text{BaSO}_4$ , excess of  $\text{Ba}^{++}$  was determined using the same indicators as used for  $\text{Mg}^{++}$  estimation. As the end point of  $\text{Ba}^{++}$  with the indicator was not clear,  $\text{Mg}^{++}$  solution of known strength was added prior to completion of titration to have a clear end point and versenate used for the same was deducted afterwards. Concentration of each ion in e.p.m. was calculated as follows:

$$\text{e.p.m. of } \text{Ca}^{++}, \text{Mg}^{++} \text{ or } \text{Ba}^{++} =$$

$$\frac{\text{Normality of versenate} \times \text{ml of versenate used} \times 1000}{\text{aliquot taken}}$$

$$\text{e.p.m. of } \text{SO}_4^{--} =$$

$$(\text{e.p.m. } \text{Ba}^{++} \text{ added} - \text{Ba}^{++} \text{ titrated with versenate}).$$

Further, as the relation between e.p.m. of  $\text{SO}_4^{--}$  and versenate used in chelating excess of  $\text{Ba}^{++}$  is linear, the amount of sulphates can be directly read from a suitably-drawn calibration curve.

Salinity Laboratory, V. B. MOGHE.  
Department of Agriculture, N. R. TALATI.  
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### ISOTHERMAL COMPRESSIBILITY OF LIQUID *n*-HEPTANE AND LIQUID *n*-OCTANE AT ATMOSPHERIC PRESSURE

THE isothermal compressibilities of *n*-heptane and *n*-octane in the liquid phase at one atmospheric pressure have been calculated from velocity of sound data and the values are compared with experimental values obtained from their P-V-T data.

The isothermal compressibility can be calculated from velocity of sound measurements<sup>1</sup> using the following well-known relations:

$$V = \sqrt{\frac{1}{\beta \phi \rho}}$$

and

$$\beta_T = \beta_\phi + \frac{\left(\frac{dV}{dT}\right)^2 \cdot \rho \cdot T}{J \cdot C_p}$$

where

$\beta_T$  = isothermal compressibility at  $T^\circ \text{K atm.}^{-1}$ ,

$\beta_\phi$  = adiabatic compressibility at  $T^\circ \text{K atm.}^{-1}$ ,

$V$  = velocity of sound at  $T^\circ \text{K (cm./sec.)}$ ,

$\rho$  = density of liquid at  $T^\circ \text{K (gm./cm.}^3\text{)}$ ,

$T$  = absolute temperature K,

$C_p$  = specific heat at  $T^\circ \text{K cal./gm.}^\circ \text{C.}$ ,

$J = 41.3$  = conversion factor for  $\text{cm.}^3\text{-atm. to calories.}$

Edulee et al.<sup>2</sup> have given the volume-temperature relation at one atmosphere for these pure liquids as

$$v = v_0 + at + \beta t^2 + \gamma t^3.$$

For *n*-heptane  $\alpha = 1.717 \times 10^{-3}$ ,  $\beta = 2.102 \times 10^{-6}$ ,  $\gamma = 1.024 \times 10^{-8}$ . For *n*-octane  $\alpha = 1.599 \times 10^{-3}$ ,  $\beta = 0.817 \times 10^{-6}$ ,  $\gamma = 1.309 \times 10^{-8}$ . The values of  $(dV/dT)_p$  at atmospheric pressure were calculated from this relation.

The  $C_p$  values considered were those obtained experimentally by Parks et al.<sup>3</sup> and have been



extended within limits to get the values are in good agreement. However, the values for *n*-octane reported by various authors are

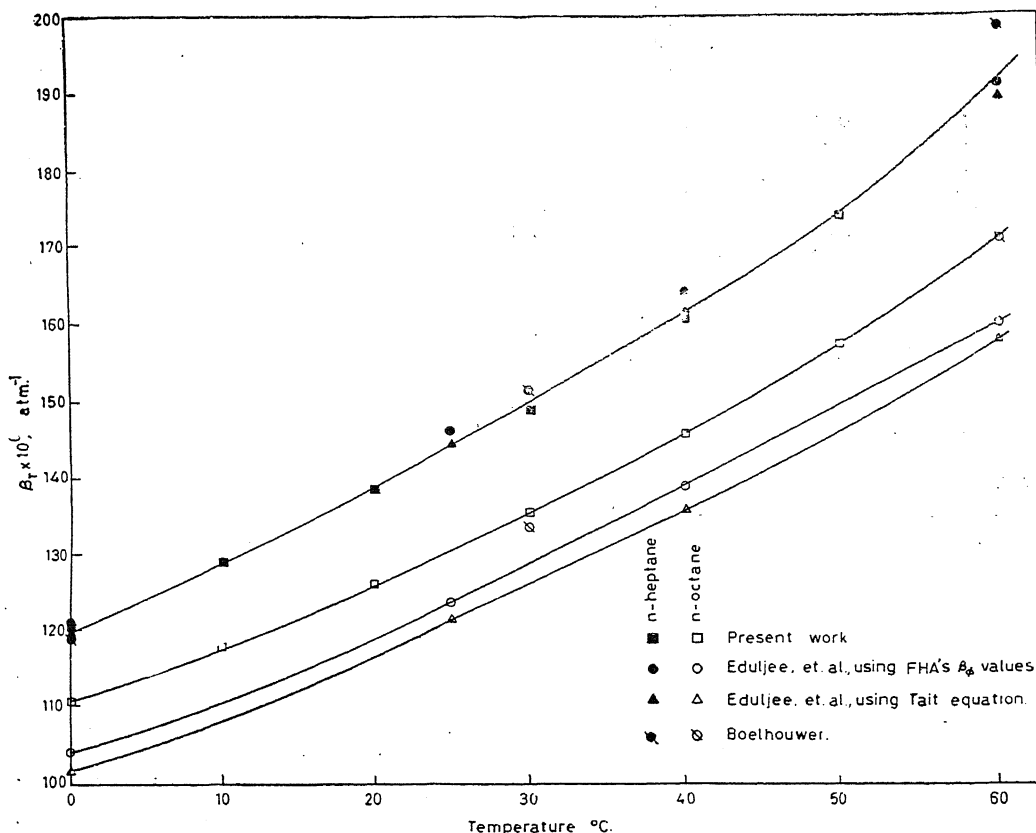


FIG. 1. Isothermal compressibility of *n*-heptane and *n*-octane in liquid phase at atmospheric pressure.

TABLE I  
Isothermal compressibility of liquid *n*-heptane at atmospheric pressure

Temp. °C.	$\rho$ gm./cm. <sup>3</sup>	$\beta_\phi \times 10^6$ atm. <sup>-1</sup>	$\left(\frac{dV}{dT}\right)_P$ $\times 10^3$	$C_r$ cal./gm. °C.	$\beta_T \times 10^6$ Eduljee <i>et al.</i> (*)	$\beta_T \times 10^6$ Eduljee <i>et al.</i> (**)	$\beta_T \times 10^6$ Boelhouwer	$\beta_T \times 10^6$ Present calculations
0	0.7005	94.9	1.717	0.5125	119.5	121.4	118.8	121.17
10	0.6920	102.4	1.717045	0.519	..	..	..	128.3876
20	0.6836	111.4	1.717096	0.526	..	..	..	138.2332
25	..	..	..	..	144.2	146.0	..	..
30	0.6751	121.4	1.717154	0.532	..	..	151.0	148.4971
40	0.6665	132.8	1.717217	0.537	161.5	163.7	..	160.1797
50	0.6579	145.8	1.717287	0.541	..	..	..	173.4860
60	..	..	..	..	188.7	190.1	197.7	..

NOTE: (\*) Eduljee *et al.*, using Tait Equation for their P-V-T data.

(\*\*) Eduljee *et al.*, using  $\beta_\phi$  values of Freyer *et al.*<sup>1</sup>

The calculated values of isothermal compressibility are shown in Fig. 1 as a function of temperature together with those obtained by other authors.<sup>2,4</sup> It can be seen that the values obtained for *n*-heptane from various sources

much lower than the present calculated values. Eduljee *et al.*<sup>2</sup> by assuming the Tait equation for their P-V-T data, have obtained very low values. The values that these authors have reported using the adiabatic compressibility

TABLE II  
Isothermal compressibility of liquid *n*-octane at atmospheric pressure

Temp. °C.	$\rho$ gm./cm. <sup>3</sup>	$\beta\phi \times 10^6$ atm. <sup>-1</sup>	$\left(\frac{dV}{dT}\right)_P$ $\times 10^3$	$C_p$ cal./gm. °C.	$\beta_T \times 10^6$ Eduljee <i>et al.</i> (*)	$\beta_T \times 10^6$ Eduljee <i>et al.</i> (**)	$\beta_T \times 10^6$ Boelhouwer	$\beta_T \times 10^6$ Present calculations
0	0.7185	86.5	1.599	0.500	101.2	103.7	..	110.4731
10	0.7103	93.6	1.59902	0.5115	..	..	..	117.6154
20	0.7021	101.6	1.599048	0.5175	..	..	..	125.8128
25	..	..	..	..	121.3	123.2	..	..
30	0.6940	110.4	1.599084	0.5215	..	..	132.834	135.0427
40	0.6859	120.4	1.599128	0.5245	135.2	138.4	..	145.4163
50	0.6777	131.4	1.59918	0.5270	..	..	..	156.7877
60	..	..	..	..	157.2	159.3	170.352	..

NOTE: (\*) Eduljee *et al.* using Tait Equation for their P-V-T data.

(\*\*) Eduljee *et al.* using  $\beta\phi$  values of Freyer *et al.*<sup>1</sup>

values of Freyer *et al.*<sup>1</sup> are also low—perhaps an error in computation. These values of *n*-octane if employed will give abnormally higher values of  $C$  for *n*-octane than could be expected experimentally—even higher than *n*-heptane. As against this, the recent experimental values of Boelhouwer<sup>4</sup> are in good agreement with our values calculated from velocity of sound data. The values are tabulated in Tables I and II.

#### SAMPLE CALCULATIONS

(i) Velocity of sound<sup>1</sup> ( $V$ ) in *n*-heptane at 20° C. is 115400 cm./sec.; density of *n*-heptane at 20° C. = 0.6836 gm./cm.<sup>3</sup>

$$V = \sqrt{\frac{1}{\beta\phi\rho}}$$

or

$$\beta\phi = \frac{1}{V^2\rho} \times 1014000$$

where

(1014000) is a conversion factor to atm.<sup>-1</sup>

$$\therefore \beta\phi = \frac{1}{(115400)^2 (0.6836)} \times 1014000$$

$$= 111.4 \times 10^{-6} \text{ atm.}^{-1}$$

(ii) For *n*-heptane, the volume-temperature relation is

$$v = v_0 + at + \beta t^2 + \gamma t^3$$

where

$$a = 1.717 \times 10^{-3}, \quad \beta = 2.102 \times 10^{-6},$$

$$\gamma = 1.024 \times 10^{-8}$$

$$\left(\frac{dV}{dT}\right)_{T=1} = a + 2\beta t + 3\gamma t^2$$

At 20° C.,

$$\left(\frac{dV}{dT}\right)_P = 1.717096 \times 10^{-3}$$

(iii)  $C_p$  value at 20° C. from Parks *et al.*<sup>3</sup> data is 0.526 cal./gm.°C.

$$J = 41.3, \quad T = (273 + 20) = 293^\circ\text{K.}$$

Now

$$\beta_T = \beta\phi + \frac{\left(\frac{dV}{dT}\right)_P^2 \cdot \rho T}{J \cdot C_p}$$

$$+ \frac{(1.717096 \times 10^{-3})^2 \times 0.6836 \times 293}{0.526 \times 41.3}$$

$$= 138.2332 \times 10^{-6} \text{ atm.}^{-1}$$

Department of Chemical Engineering,  
Indian Institute of Science,  
Bangalore-12 (India), February 26, 1964.

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#### A NOTE ON SOME INTERESTING SEDIMENTARY STRUCTURES IN THE SIWALIK FORMATIONS OF DOON VALLEY, UTTAR PRADESH

DURING the course of systematic groundwater investigations by way of exploratory drilling in Doon Valley, Uttar Pradesh, a few geological traverses were conducted along Birhani and Suarna Nadi sections covering the Siwalik formations along the northern fringe of the Valley. The investigations brought to fore interesting Sedimentary Structures—probably the first of its type as far as Siwalik formations are concerned—at the following localities.

- (i) Birhani Nadi Section, South of Galjwari Village (Fig. 1)  
(30° 23' 45" : 78° 02' 25" ; 53-J/3)
- (ii) Western Flange of Anghalia Hills (3,344) and East of Nun Nadi  
(30° 23' 50" : 78° 02' 55" ; 53-J/3)

(iii) Suarna Nadi Section between Thangaon and Donga Villages.

30° 26' 27" : 77° 47' 55" ; 53-F/15

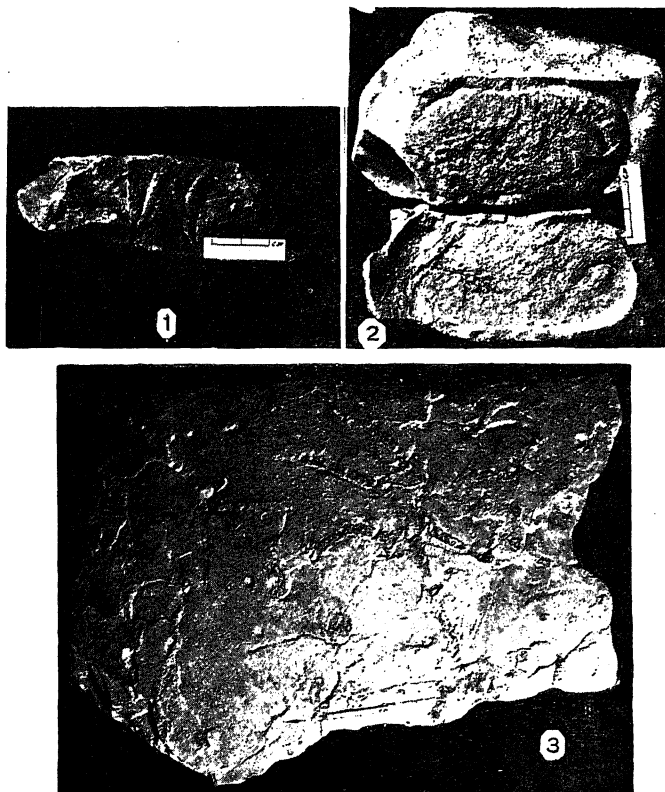
The Sedimentary Structures are noted in the Lower and Middle Siwalik formations. They are associated with pale green to olive and flesh-red to pink-coloured argillaceous beds of Lower and Middle Siwaliks at the first two localities and light-green clays and silt stones of Lower Siwaliks in the Suarna Nadi section.

The salient features regarding the structures are as follows :

(a) *Worm borings*.—(i) In the *in situ* the disposition of the worm bores or tubular structures are random—the tapering of tubes is not strictly confined from top to bottom of the bed and some are observed even parallel to the bedding. (ii) All the tubes are not straight and vertical—they are bent, curved and inclined also (Fig. 1). (iii) They are not of uniform diameter; they even exhibit different diameters

in the same tube; the maximum diameter recorded being 8 mm., the minimum is almost of negligible diameter. (iv) Signs of minor deformation (slip or shift in the tube) are also recorded in some of the tubes. (v) In thin sections the argillaceous bands rich in worm borings are constituted of illitic clay; longitudinal section of the tube indicates limonitic leaching away from the border of the tube; the same is not noticed inside the tube except for the presence of abundant unleached magnetite; there is no noticeable difference in the composition of the material inside the tube and that outside the same; the circular cross-sectional area of the tube in a transverse section indicates radiating feature on the periphery.

(b) *Pellet structures*.—The pellet structures are essentially observed in the pale green and pink-coloured clay beds in the Birhani Nadi section (Fig. 2). In their size (lengthwise) they range from 10 mm. to a maximum of



FIGS. 1-3. Fig. 1. Worm borings (tubular structures) indicating prominent bend and varying diameter in the same tube and also individual tubes; Birhani Nadi area. Fig. 2. A pellet structure in the argillaceous beds; note the presence of worm boring inside the pellet structure and the same in places cutting across the periphery of the pellet structure; Birhani Nadi area. Fig. 3. Worm tract markings preserved on the (silt stone) argillaceous beds of Lower Siwaliks in Suarna Nadi section.

87 mm. It is not uncommon that the worm borings are also seen associated with the pellet structures.

These features in the argillaceous beds may be due to volume shrinkage resulting in shelly or pellet structures.

(c) *Swash marks*.—Some of the structures which greatly resemble Swash marks are faintly preserved in the light green, soft clay (shaley) beds encountered in the Birhani Nala section.

(d) *Worm tracts*.—Worm tracts are noticed particularly in the silt stones interbedded with clays and sandstones of Lower Siwalik horizon in the Suarna Nadi section (Fig. 3). It is also observed that generally the worm tracts end against worm borings indicating probably that the same worm has made a re-entrance into a self-made second boring. Further studies on worm tracts to refer them to a particular genus are in progress.

The presence of the above structures (especially worm tracts, borings, etc.) in the Middle and Lower Siwalik beds of Doon Valley indicate shallow water conditions of deposition which might have been subjected to occasional aeration of short duration due to uplift of the beds as revealed by the oxidised and leached material along the borders of the tubular structures and bedding planes of the formations. The tubular worm borings subjected to aeration might have been filled with the same argillaceous material during the subsequent depositional phase which resulted probably due to subsidence of the basin of deposition within a short interval of time.

The results of further studies on the sedimentary structures will be published elsewhere.

The authors wish to place on record their sincere thanks to Sri. Mahavir Prasad, Chief Engineer, ETO, for the keen interest he has evinced in the work and also for the permission he has accorded for publishing the note.

Exploratory Tubewells      K. V. RAGHAVA RAO.  
Organisation,              P. P. S. GREWAL.  
Ministry of Food and Agriculture,  
Jamnagar House, Mansingh Road,  
New Delhi-11, October 30, 1963.

## THE NAHANS AS EQUIVALENT OF THE KAMLIALS

DURING the course of investigation of the Lower Shivaliks around Kalka it became incumbent to investigate the rocks of the area between Kalka and Nalagarh as well as northward up to Subathu. For this purpose several traverses were taken in the area north of the Pinjaur dun.

Several geologists including Medicott (1894), Pilgrim (1924), Heron (1936), Lahiri (1941, 1953) and Raina (1954) have worked in this area but no fossils have been discovered so far except some limb-bones from the red clay exposed near Barian village and a *Mastodon* tooth in the purplish clays immediately north of the Pinjaur dun. Thus the age of these rocks could not be satisfactorily determined and naturally, their correlation with other formations in the standard scale was not feasible. In the past, attempts have been made to correlate them on the basis of lithology only.

The aim of this paper is to describe briefly the lithology and structure of the rocks found in the area and to correlate them with standard Indian stratigraphic units on the basis of the vertebrate fossils which have been collected from this region since 1962, details of which will be given in a later contribution.

Lithologically the Lower Shivaliks of the area can be divided into three units as follows:

3. Alternation of red clays and grey sandstones, the beds being almost of equal thickness.      .. Chini
2. Grey sandstones with pseudoconglomeratic layers and thin beds of red clay.      .. Kamli
1. Purplish, red, pink and yellowish clay with thin beds of red siltstones and crushed grey sandstones.      .. Kamli

The purplish clay unit is highly folded and faulted and the pseudoconglomeratic sandstone unit has occasionally also been involved in this. Anticlines and synclines of great amplitude occur in the third upper unit. A geological section from Nalagarh in the south of Ramshala in the north is given below to illustrate the tectonic features of the area.

A *Mastodon* tooth was discovered from the purplish clay unit by Pilgrim besides, more recently, some limb-bones, a tusk and part of a *Mastodon* tooth. No vertebrate fossils have been discovered at all so far from the pseudoconglomeratic sandstones but fossil-wood is generally found, and even a fossil tree trunk was recently excavated near Kalka. Some

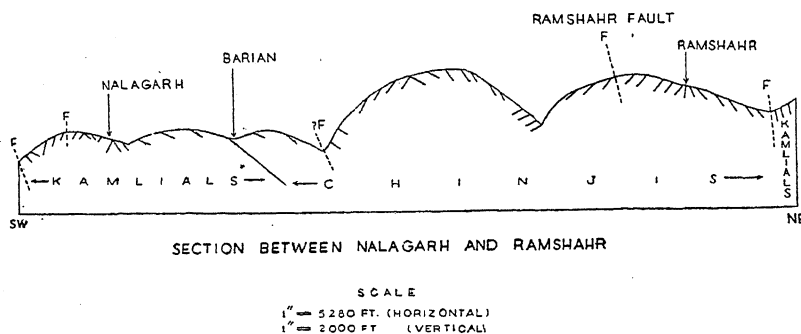


FIG. 1

limb-bones were collected from near Barian village earlier from the third unit but, more recently, as many as five hundred specimens have been collected from this unit near Ramshahr.

The fossils collected near Ramshahr include *Conohyus sindiense*, *Listrodon pentapotamiae*, *Hipparion theobaldi*, *Aceratherium perimense*, *Selenoportax vexillarius* and *Mastodon*. Most of the forms collected from the area are characteristic of the Chinjis; therefore, this unit is correlated with the Chinjis. Since the pseudo-conglomeratic sandstones which are lithologically similar to the Nahans conformably underlie the Chinjis of the area, the former may be correlated with the Kamlials. The purplish clay unit appears to be a part of this sandstone. Therefore, it is correlated with the Kamlials for the time being.

Department of Geology, M. R. SAHNI.  
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## STUDIES ON PLANT-PARASITIC NEMATODES OF KERALA:

### II. A List of Plants Attacked by Root-Knot Nematode, *Meloidogyne* Spp.

In the earlier reports, Nadakal<sup>1,2</sup> has stressed the need for the survey of plants attacked by *Meloidogyne* spp. Surveys and lists of host plants of these nematodes have been made in other countries by Goodey *et al.*,<sup>3</sup> Martin<sup>4</sup> and Minz,<sup>5</sup> among others, and recently in North India by Nirula and Kumar.<sup>6</sup> The present work

has been done during the period extending from March to September, 1963. Plants were collected from different localities in Kerala and species of parasites determined mainly by the examination of perineal cuticular patterns. Of the two species identified, *M. incognita* (Kofoid and White) and *M. javanica* (Treub), the former appears to be the most common. Table I gives the names of host plants with some characteristics of infection and parasites recovered from them.

The list given in Table I includes both weeds and plants of economic importance. A knowledge of susceptible weeds growing in crop fields would be valuable in devising control measures for *Meloidogyne* spp. as such plants may serve as "reservoir hosts" in maintaining the parasite population in nature. Samad<sup>7</sup> from Pakistan and Rangaswami *et al.*<sup>8</sup> from India have reported that the plants *Ageratum conyzoides*, *Eclipta alba* and *Vernonia cinerea* can serve as hosts of *M. javanica*.

Plants examined from certain localities alone showed infection. Frequency and intensity of infection of susceptible plants have been found to vary from place to place. The finding of the three sterile larvæ in the remarkably nodulated root-system of *Desmodium* suggests its unsuitability as a potential host.

It is interesting that males were noticed only in three cases of heavy infections. This may lend support to the view of Tyler<sup>9</sup> that the appearance of males in *Meloidogyne* infections is an index of the lowering of the vitality of host plants. The colouration of egg-mass matrix seems to be characteristic of the plant species attacked. Ellenby<sup>10</sup> has reported polyphenol tanning in the cyst wall of *Heterodera rostochiensis* and it is possible that the colour of the matrix may also be due to tannins; if so the intensity of colouration of the egg-mass matrix

TABLE I

Host plant	Parasite	Egg-output	Colour of egg-mass matrix	Male	Nature of attack
<i>Ageratum conyzoides</i> L.	.. <i>M. incognita</i>	High	Colourless	Present	Heavy infection ' and galling; females invade stele
<i>Amarantus gangeticus</i> L.	.. "	Low	Pale yellow	..	Mild infection and galling
<i>Amorphophallus campanulatus</i> Bl.	.. "	"	Colourless	..	"
<i>Benincasa cerifera</i> Savi.	.. "	"	"	..	"
<i>Capsicum frutescens</i> L.	.. "	Egg-mass not observed	..	..	Mild infection and galling. females invade stele
<i>Colocasia antiquorum</i> Schott	.. "	"	..	..	Mild infection and no galling
<i>Curcuma longa</i> L.	.. "	High	Colourless	..	Heavy infection ; galling on rootlets only
<i>Desmodium triflorum</i> DC. Prodr.	.. "	Only three moribund larvae recovered	..	..	"
<i>Eclipta alba</i> Hassk	.. "	Low	Pale yellow	..	Heavy infection; females: invade stele
<i>Impatiens balsamina</i> L.	.. "	"	"	..	Heavy infection and galling; females invade stele
<i>Lycopersicon esculentum</i> Mill	<i>M. javanica</i>	High	Yellow	..	Heavy infection and galling
<i>Koempferia galanga</i> L.	.. <i>M. incognita</i>	"	Colourless	Present	"
<i>Maranta arundinacea</i> L.	.. "	Low	Pale yellow	..	Mild infection and no galling
<i>Momordica charantia</i> L.	.. "	"	"	..	Heavy infection and no galling
<i>Sida rhomboidea</i> Roxb.	.. <i>M. javanica</i>	High	Yellow	..	"
<i>Vernonia cinerea</i> Less.	.. <i>M. incognita</i>	"	Pale yellow	..	Heavy infection; galling even on tap roots slightly above soil level

of *Meloidogyne* would be a measure of tannin contents of the host plants.

The senior author wishes to thank C.S.I.R., New Delhi, for financial help, the authorities of Mar Ivanios College for providing space and facilities, and Mr. V. V. Joseph for identifying the host plants.

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## FAT AND SEX IN BIVALVE MOLLUSCS

THE fat content, and its variations and the occurrence and distribution of fatty acids in several groups of animals have been investigated by several authors. Recently Shorland<sup>2</sup> has reviewed the latter aspect and discussed briefly whether the lipid make-up in organisms could be related to their position on the phylogenetic scale. An aspect of study which does not seem to have received attention is whether the composition of fat varies in relation to sex. In our laboratory, we have undertaken a comprehensive investigation of this aspect. The present note communicates the differences in respect of the chief analytical constants of fat in the male and female oyster (*Ostrea madrasensis* Preston) and also in those of the backwater clam, *Meretrix casta* (Chemnitz).

The fat was extracted in Soxhlet's apparatus using ethyl ether. The fat from each sex was extracted separately. For each estimation, five samples, with five specimens in each, were taken.

The saponification value and iodine number were estimated as described by Hawk *et al.*<sup>1</sup>

TABLE I  
Composition of body fats in *Meretrix* and *Ostrea*

Animal	Sex	% total fat (to dry wt. of tissue)	Iodine number wij's method 28°—32°	Saponification value	Saponification equivalent
<i>Meretrix casta</i>	Male	3.587 ± 0.148	52.820 ± 0.809	245.400 ± 7.200	229.202 ± 5.839
	Female	4.519 ± 0.231	85.800 ± 0.657	105.700 ± 4.420	533.552 ± 19.478
<i>Ostrea madrasensis</i>	Male	6.960 ± 0.233	26.020 ± 4.803	219.530 ± 5.586	259.612 ± 7.760
	Female	9.340 ± 0.150	42.050 ± 6.654	166.000 ± 3.160	236.540 ± 9.299

Table I summarizes the results of total fat, saponification value and iodine number in the two sexes of the two species.

It will be observed that the saponification value of the male is higher than that of the female and the iodine number of the fat of the female is higher than that of the male. These differences in fat composition in relation to sex are observed in both the bivalve species included in the present study. The results reported here would indicate that the fat differs in the two sexes in respect of fatty acid chain-length as well as in the degree of unsaturation. Further work is in progress, relating to the differences in fat composition with reference to sex in different species of marine organisms.

The author's thanks are due to Prof. R. V. Seshaiya, Director, Marine Biological Station, Porto Novo, for suggesting the problem, and for instruction and guidance.

Marine Biological Station, S. KASINATHAN.  
Porto Novo, November 20, 1963.

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### ON SOME POLYCHAETES FROM LITTLE ANDAMANS

ALTHOUGH Fauvel<sup>1,2</sup> has recorded about 90 species of Polychaetes from the Andamans (North, Middle and South Andaman, deeper regions of the Andaman Sea from the collections made by the R.I.M.S. 'Investigator') there has been no record of any Polychaete from the littoral region of Little Andaman Island. The present note is a preliminary report on the Polychaetes collected by a party from the Zoological Survey of India during April-May 1961 from Tailanda (Lat. 10° 44' N., Long. 92° 40' E.), Kwate-tu-kwage (Lat. 10° 35' N., Long. 92°

34' E.) and Tokoibuea (Lat. 10° 53' N., Long. 92° 32' E.) of the Little Andamans.

We have been able to identify the following eight species belonging to seven Families:

Sedentaria—*Sabellaria spinulosa* Leuckart [Sabellariidae]; *Nicolea gracilibranchis* (Grube) [Terebellidae]; *Clymene* (*Euclymene*) *annandalei* Southern [Maldanidae].

Errantia—*Amphinome rostrata* (Pallas) [Amphinomidae]; *Syllis gracilis* Grube [Syllidae]; *Perinereis cultrifera* Grube [Nereidae]; *Lysidice collaris* Grube, *Eunice antennata* Savigny [Eunicidae].

Of these, the two sedentary species, *Nicolea gracilibranchis* Grube and *Sabellaria spinulosa* Leuckart have not been previously recorded from the Andaman waters. Since the sedentary polychaetes form a major component of the fouling complex in the tropics, the present extended range of distribution of these two species, apart from being of academic interest, may have practical significance in the fouling of underwater surfaces in the Andaman seas.

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Calcutta, October 31, 1963. A. GHOSH.

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### A HITHERTO UNDESCRIBED HYDRORECEPTOR ORGAN IN MILLIPEDES

THOUGH millipedes are known to react to moist and dry conditions<sup>1-3</sup> it is not clear how they sense such changes. In a recent study it has been noted that the millipedes of the species *Cingalobolus bugnioni* show a change in mode of life correlated with the seasons.<sup>4</sup> In the rainy season they are active, moving about on the wet soil and with the onset of dry conditions in summer, they bury into the soil and remain inactive, suggesting that they react to changes in the moisture conditions of the soil.

It was felt of interest to investigate the factors that enable them to sense such changes.

For this purpose the following experimental procedure was tried. The millipedes were made to develop an avidity for water by exposing them over KOH for an hour at 40° to 45° C., when they lose water as much as one-fourth of their body weight; later when released in a chamber sprinkled with water they were noted to suck several drops of water very quickly. In this connection it was observed that only on coming in contact with water they were able to sense its presence and react as above. It may therefore be inferred that a special hydrosensor organ may be present in these millipedes.

To find if such an organ does exist, and if present its location, the following experiments were carried out. Some millipedes were exposed to KOH and released in a chamber sprinkled with water. The experimental animals were coated with a thick solution of celloidin in different parts of the body, to prevent the organ in question if present in that region, from responding to the presence of water. When organs or parts of the body other than the ventral region of the anteriormost five segments of the body were coated, the behaviour of such forms did not show any marked differences from the control animals which were untreated. But the experimental animals, in which the ventral region of the anteriormost five segments of the body was coated with celloidin, the millipedes were not able to react to water and behaved very different from the normal control animals. It may be inferred that the ventral region of the anteriormost segments contain probably the sense-organ in question. The above experiments were repeated on a large number of millipedes and it was invariably found that the ventral region of the collar segment is responsible for the reaction to the presence of water. It may be presumed that the hydrosensor organ may be present in this region.

To test if the above assumption is valid the collar segment was sectioned after double embedding in celloidin and wax; serial sections were cut and stained in Mallory's triple stain. Such sections showed, in the narrow sternite of the collar segment, just behind the base of the gnathochilarium, a pair of depressions which appear to be the organs in question (Fig. 1); one on each side near the points where the sternite meets the pleurotergite.

Figure 2 shows a section passing through the organ, comprising an oval cavity in which are present numerous elliptical structures projecting into its lumen. The segmental nerve runs along the side and gives off four branches three of which form a plexus of multipolar nerve cells which give off terminal processes ending in the branches in the hypodermis which in this region is very much attenuated. The fourth branch runs towards the base of the vesicle after piercing through its wall runs along the base of the elliptical structures and gives a number of nerve fibres to them. The above mentioned features are suggestive of a sense organ. Similar structures in identical positions have been noted in the collar segments of the millipedes belonging to three other families found commonly in South India, viz., *Theridion* sp. (Family: Harpagophoridae), *Polydesmus* sp. (Family: Strongylosomidae) and *Aulacobolus* sp. (Family: Pachybolidae).

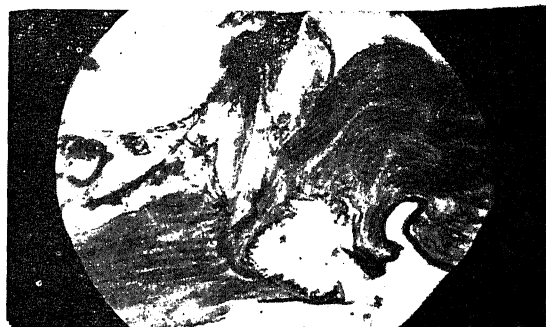


FIG. 1. Photomicrograph of the hydrosensor organ of *Cingalobolus bugnioni* stained by Mallory's method.



FIG. 2. Transverse section through the hydrosensor organ of *Cingalobolus bugnioni* stained by Mallory's method.

The components of the sense-organ in all the millipede groups, examined, are a pair of cuticular vesicles situated at the junctions of the sternite and pleurotergite, one on each side, of the collar segment just behind the base of the



gnathochilarium; numerous elliptical structures projecting into the vesicle, connected by nerve fibres or nerve cells with segmental nerve branch which give off separate nerve branches to the organ.

The hydroreceptor organ described above, recalls the tarsal organ of spiders<sup>5</sup> and tuft organs of *Pediculus*<sup>6</sup> in being formed of cuticular pit sensory processes and nerve tracts connected to them; but differs from them in its function.

I am grateful to Professor G. Krishnan, Director, for his kind guidance and encouragement during the course of this investigation. I am indebted to the authorities of the University Grants Commission for the award of a Research Fellowship.

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# ON THE LOCATION OF A POSSIBLE SPAWNING AREA FOR THE PENÆID PRAWN, *METAPENAEUS MONOCEROS* FABRICIUS, OFF COCHIN

We have very little information on the exact areas where many of the penæid prawns of our coast mature and breed except for the smaller species, *Metapenaeus dobsoni* and *Parapenaeopsis stylijera* (Menon, 1951 and 1953). Although Panikkar and Menon (1955) have stated that older prawns pass into comparatively deeper waters, we have no knowledge on the actual breeding areas of such larger penæids as *Metapenaeus monoceros*, *M. affinis* or *Penaeus indicus* which actively support the commercial fishery. In the case of *Metapenaeus monoceros* as in other species, the indigenous fishery is limited to the inshore area and this is supported mostly by immature and smaller specimens. The mechanised boats operate between 15 and 30 metres and their catches consist of prawns of a comparatively larger size group. But the proportion of mature individuals in these catches has been low in the months in which they are landed in fairly good numbers, namely November and December, so that it was necessary to seek elsewhere the place

of sojourn of the spawning populations as a knowledge of the spawning behaviour and breeding areas of prawns is quite essential to understand the several factors that influence the fluctuations in the fishery.

Spawning survey cruises off the Cape Comorin-Mangalore coast were carried out during the monsoon and post-monsoon season with the added facility available for work on board the research vessel "VARUNA" and trial trawling for prawn beds were regularly carried out along with other biological and oceanographic investigations. During the fourth monsoon cruise of 1963 (Cruise No. 98-V-35) the experimental trawling operation carried out on 13th August at and around the sand shelves in the 50-60-metre area (N. 9° 51'-E. 75° 52') off Cochin (Fig. 1), an half hour trawl using a shrimp

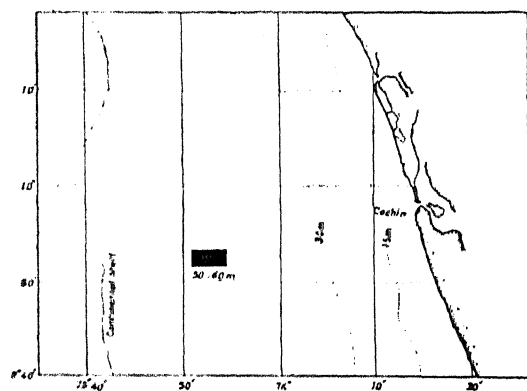


FIG. 1. Map showing the relative position of the spawning ground. ●—Location of spawning area.

trawl yielded an exclusive catch of 25 kilograms of large-sized *Metapenaeus monoceros*. The catch was quite striking in that the entire haul consisted of very large individuals, mostly females, in advanced stages of maturity. The bottom at this ground showed an admixture of sand and silt. The water temperature at 0 and 50 metres was 27-67° C. and 22-20° C. while the salinity values at these depths were 34-30‰ and 34-99‰ respectively. The low bottom temperature of the area also appears to be highly significant.

As could be seen from the histogram (Fig. 2) the mode in females is in the 141-155 mm. group and the size ranged from 120 mm. to 176 mm. The females contributed to 75% of the catch and were fully mature. The mode in the case of males is 120-135 mm. group.

The earlier studies carried out on this species (George, 1959) have shown that breeders are

absent in the backwaters as well as in the area of operation of the indigenous crafts, although post-larval and juvenile stages are available. Hence the present observation on the occurrence of almost exclusively of large-sized fully mature prawns indicates that the area from which these were obtained could be a spawning ground for the species.

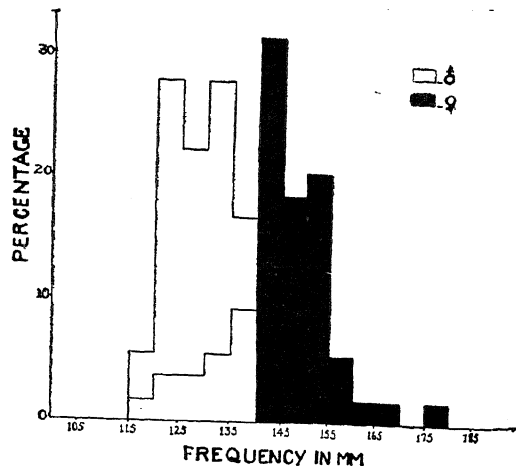


FIG. 2. Length frequency distribution of the prawns caught from the ground.

This newly discovered concentration of large-sized prawns in the 40-60-metre area may offer new commercial grounds for larger prawns as could be found out by further trial operations and their exploitation may pose problems of conservation. So long as the spawning stocks are not within the limits of the commercial trawl fishery any depletionary tendency due to pressure of fishing in these quick-growing species of prawns seems unlikely. But when commercial fishing operation is to be carried out on the spawning stock it has to be done quite judiciously as undue removal of potential spawners may adversely affect the natural fluctuations in the fishery and the rate of recruitment of fry and early larvae into the backwaters and lakes. This is particularly important because of the well-established backwater fishery of juvenile prawns which cannot be allowed to be affected adversely.

The authors are grateful to Dr. S. Jones for his keen interest in these investigations and to the officers and crew of "R.V. VARUNA" for all help and assistance on board the research vessel.

Central Marine Fisheries P. C. GEORGE.  
Research Institute M. J. GEORGE.  
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### INDIAN SPECIES OF THE GENUS *HIEROCHLOE* GMEL. EX R.BR.

SINGH AND KHANNA<sup>1</sup> reported the occurrence of *Hierochloa odorata* (L.) Beauv. in Central Nepal at an altitude of 11,000 ft. and this was claimed to be the first report of this aromatic species from the Himalayas. No mention was made, however, of the extent of its vegetation. They also stated that only four other species of this genus occur in Khasi Hills, Sikkim Himalayas to Lahul Valley between 11,000 and 16,000 ft. altitude. From their account it is not clear which are the species available in the Indian Union. In this respect the following account may be of interest:—

Hooker<sup>2</sup> recorded six species in *Fl. Br. Ind.* under *Hierochloa* with one more doubtful species (viz., *H. latifolia* Kunth = *Centotheca lappacea* Desv.). *H. sikkimensis* Maxim. was not included in this list. Recently Bor<sup>3</sup> placed four of these species under three species of *Anthoxanthum* Linn. (which, incidentally, also are sweet-scented grasses), keeping three others under *Hierochloa* proper. A fourth species (*H. tibetica* Bor), according to him, was collected from South Tibet. There are, therefore, four species of *Hierochloa* growing in the Himalayan regions of India, Nepal and Tibet (including *H. odorata*). Of these only two species, viz., *H. laxa* R.Br. ex Hook.f. and *H. khasiana* Clarke ex Hook.f., according to Bor,<sup>3</sup> grow in the Indian Union. *H. khasiana* was collected from Khasi Hills at an altitude of 4,500 ft.<sup>4</sup> It appears to be available also at lower altitude of 3,500 ft.<sup>5</sup>

*Hierochloa* consists of nearly fifty species (as recorded in *Index Kewensis*) which are widely distributed and many of them are aromatic.<sup>3,6</sup> But it appears that except *H. odorata* (the rhizome of which contains coumarin<sup>6</sup>) none of the other species of this genus has ever been analysed for its aromatic substances. This was pointed out elsewhere recently by the present author who recommended for analysis two

species of *Hierochloa*, viz., *H. khasiana* and *H. gracillima* Hook.f. [= *A. sikkimensis* (Maxim.) Chwi, according to Bor<sup>3</sup>] and one of *Anthoxanthum*, viz., *A. odoratum* Linn.<sup>7</sup>

Botanical Survey of India, J. K. CHOUDHURY.\*  
Calcutta, October 15, 1963.

\* Present address: Darjeeling Government College, Darjeeling.

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#### A NEW AECIAL HOST FOR PUCCINIA VERSCOLOR

*Puccinia versicolor* Diet. and Holw., parasitising members of the Andropogoneae, is circumglobal, in the warm regions of the world. The type species was collected by Holway in Mexico on *Heteropogon melanocarpus*. In India the rust has been reported by several investigators on *Heteropogon contortus* Beauv. and was known as hemi-form until Thirumalachar and Narasimhan<sup>3</sup> described the aecial stage of the rust on *Plectronia parviflora* Bedd. which was previously described under the name *Aecidium plectroniae* Cke. This aecial stage and the uredial and telial stages on *Heteropogon* are known to occur in Australia and South Africa also.

In the course of further studies on heteroecious rusts on grasses in India, yet another aecial host for *Puccinia versicolor* has been found on *Lantana indica* Roxb. which is a wild plant growing in the deciduous forests. The uredial stage on *Heteropogon contortus* is hypophyllous, yellowish-brown with the wall irregularly and conspicuously thickened to give the spore a stellate lumen. This character along with paraphysate uredia, measurements of urediospores and teliospores confirmed the identity of the rust as *P. versicolor*.

The possible connection between the aecial stage on *Lantana indica* and *P. versicolor* on *H. contortus* was first surmised on the basis of field studies and later confirmed by cross-inoculation experiments. The teliospores were germinated on slides and used for inoculating

seedlings of *Lantana indica* raised under rust-free conditions. The teliospores germinated by a 4-celled basidium, bearing globoid sporidia at the tips of sterigmata. The inoculated plants were inclosed in moist chambers for 48 hours after which they were kept in the green-house. Successful inoculation became evident after a period of 12 to 15 days by the development of orange-yellow pycnidia followed by cupulate and peridiate aecia on the lower side of the leaf. In a similar way, aeciospores from *Lantana indica* were used to cross-inoculate *Heteropogon contortus* seedlings, and successful infection with the development of uredia was observed.

Pycnidia are epiphyllous, orange-yellow, sub-epidermal, flask-shaped with well-developed ostiolar paraphyses, 70 to 95  $\mu$  wide. Aecia are hypophyllous, subepidermal orange-yellow, erumpent, peridiate, 200 to 275  $\mu$  in diameter; Peridial cells angular to globoid, thick-walled, rugose, 25-35  $\times$  15-35  $\mu$ . Aeciospores angularly globoid due to compression, minutely and densely verrucose, wall 1.5  $\mu$  thick, measuring 18-30  $\times$  17-22  $\mu$ .

On the leaves of *Lantana indica* Roxb., Baglon, Nasik, Maharashtra, 31st August, 1960 Leg. B. V. Patil.

The aecial stage completely agrees with that on *Plectronia parviflora* except for the fact that the aeciospores on the latter host are hyaline and not yellowish. The original description of *Aecidium plectroniae* also mentions the aeciospores as being yellow in colour. Cummins<sup>1</sup> stated that *Aecidium evansii* P. Henn. which occurs on *Lippia asperifolia* in Africa and Mexico should be considered in future studies on the aecial hosts of *P. versicolor*, since the measurements and general characteristics of the aeciospores are similar to those of *A. plectroniae*. This is interesting because *Lippia* and *Lantana* both belong to the family Verbenaceae. *A. lantana* Mayor described by Mayor<sup>2</sup> on *Lantana hispida* in Columbia, South America, may also be the aecial host of *P. versicolor*, though the measurements given by Mayor shows them to be slightly smaller (18-21  $\times$  14-18  $\mu$ ).

Department of Botany, B. V. PATIL  
University of Nagpur, M. J. THIRUMALACHAR.  
and

Hindustan Antibiotics  
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# ON THE OCCURRENCE OF BRANCHED FEMALE RECEPTACLE IN A SPECIES OF *MARCHANTIA* cf. *GRISEA* BURGEFF

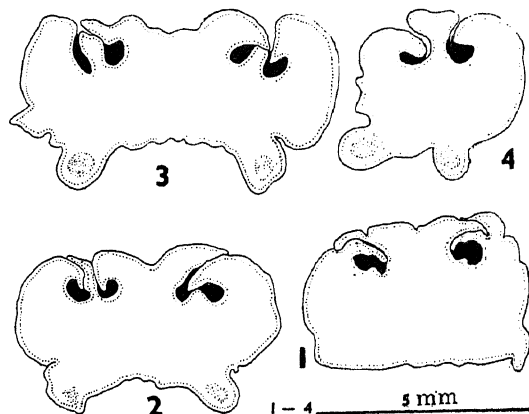
BRANCHED female receptacles have been described by Kashyap (1929) and Khanna (1930) in *Marchantia palmata* Nees while Burgeff (1943) described branched female receptacles in *M. hybrida* mut *androgenea* (Fig. 154, page 143),  $F_1$  hybrid of *quadripes* ♀ × *helix* (Fig. 166, page 152) and mutant hybrid *picturata* ♀ × *Acaulis prolifer* (Fig. 171, page 156).

During the course of an examination of a rich collection of *Marchantia* from several localities in South India during October 1962 an abnormal plant was noted from Ootacamund. The species is interesting in being different from all other known species of *Marchantia* occurring in India, in their robust size, general characters of male and female receptacles, gemma cups and thallus anatomy. The plants approach *M. grisea* instituted by Burgeff (1943) from Java and seem to have been regarded as *M. palmata* for a long time. A detailed description of the plant occurs elsewhere.

The abnormal specimen has a bilobed thallus; the right lobe has two normal female receptacles while the left lobe has two female receptacles with a common branched stalk (Fig. 5). The receptacles are convex, 7-9-lobed and asymmetrical. The branches (Br) are 9 mm. long and the purple branches of the stalk are  $\frac{1}{4}$  colourless just below the receptacles. Each branch has two rhizoidal furrows. The unbranched portion of the stalk is 2.1 cm. long, it has four distinct rhizoidal furrows in the middle zone and the bifurcation point (Figs. 2, 3) while at the base the two pairs of the rhizoidal furrows are not so distinct as in the middle but can be realised by a small ridge in each furrow (Fig. 1). The assimilatory zone of the stalk gradually increases from the base towards the apex of the stalk.

Chandra (1963) while describing the compound female receptacles of *Reboulia* pointed out that occurrence of such receptacles suggest the phyletic line which led to the evolution of *Reboulia* from *Marchantia* or *Marchantia*-type ancestors, having two or more rhizoidal furrows. It appears that in this phyletic line simplification of the receptacle along with the reduction in the number of rhizoidal furrows of the stalk was involved. The occurrence of branched receptacles, having more rhizoidal furrows in the stalk in contrast to generally two rhizoidal furrows in *Marchantia*, suggests that the same

nature of the evolutionary process was involved in the evolution of *Marchantia*. Evidently such observations imply that the present-day *Marchantia* has been evolved from a more complex ancestor ('Pro-*Marchantia*') and thus the



FIGS. 1-4. Transverse sections of the branched stalk, through 1. base, 2. middle zone, 3. bifurcation point, 4. branch.

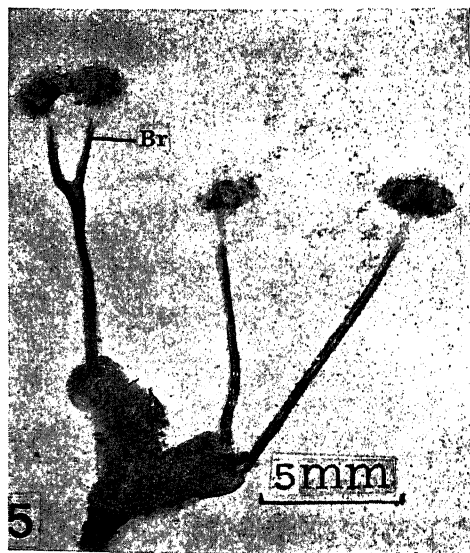


FIG. 5. Photograph of the specimen, note the branching of the stalk. Br, branch.

existing *Marchantia* represent reduced form in themselves. The view may be further supported if the depressions on the stalk of the receptacles in *Marchantia* and other genera of *Marchantiales* may be regarded as the remnant rhizoidal furrows.

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RAM UDAR.  
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# AN INTERSPECIFIC CROSS IN THE GENUS *Pennisetum* INVOLVING TWO BASIC NUMBERS

SPECIES derived from the basic numbers 5, 7, 8 and 9 have been reported so far in the genus *Pennisetum*.<sup>1</sup> From the studies of meiosis in hybrids involving higher polyploid species with  $x=7$  and  $x=9$ , it has been assumed that some degree of affinity exists between the chromosome sets of the species belonging to these two groups.<sup>2,3</sup>

Cytogenetical studies carried out in this laboratory on the two diploid species *P. typhoides* ( $x=n=7$ ) and *P. orientale* ( $x=n=9$ ) and their  $F_1$  hybrid ( $2n=16$ ) have distinctly revealed for the first time the close relationship between these two basic numbers of the genus *Pennisetum* Rich.

7 *typhoides* chromosomes, one to two showed pairing with a chromosome each of *orientale*. From among the remaining ones of *typhoides*, two to three showed either a loose pairing or a secondary association with a chromosome each of *orientale*. One to two pairs were also formed by autosyndesis among *orientale* chromosomes (Fig. 1).

The intergenomic pairing thus appears to suggest homeology between *typhoides* and *orientale* genomes and their common ancestry. The observations further suggest the origin of *orientale* set of 9 from a basic set of 7 chromosomes.

Of the four hybrids reported in literature including the present one of the crosses involving pearl millet with other *Pennisetum* species, the present cross is a second instance wherein the  $F_1$  hybrid showed considerable amount of heterosis in forage characters, the first being pearl millet with Napier grass.<sup>4</sup> The homeology of the genomes of the two species, *typhoides* and *orientale*, and the partial fertility of their  $F_1$  hybrid offer opportunities for securing amphidiploid and recombination forms superior

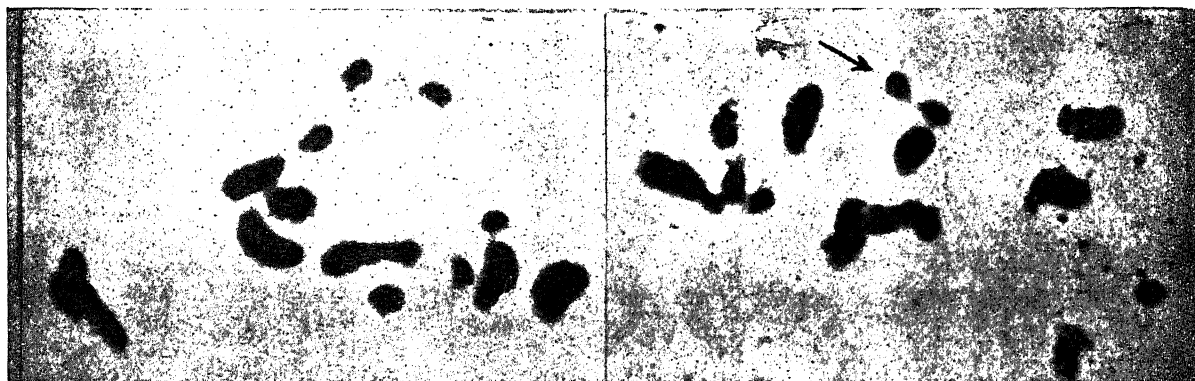


FIG. 1 (a-b), Fig. 1 (a). P.M.C. of  $F_1$  hybrid of *Pennisetum typhoides* and *P. orientale* showing allosyndetic pairing between some of 7 large-size *typhoides* chromosomes and 9 small-sized *orientale* chromosomes at Metaphase. Fig. 1(b). P.M.C. of above hybrid showing autosyndetic pairing between 2 chromosomes of *orientale* (marked with an arrow) at late Meta. I.

The cytological behaviour of the parental species (*P. typhoides* and *P. orientale*) was normal forming 7 and 9 bivalents respectively at meiosis. In the case of *P. orientale*, however, it was observed that two of its chromosomes often showed secondary association with its other two. The chromosomes of these two species showed striking size differences, *typhoides* chromosomes appearing to be more than double the size of *orientale* chromosomes at metaphase I. The detailed analysis of the chromosome pairing of the  $F_1$  hybrid has revealed that of the

to one or the other parent in respect of forage and/or grains.

Division of Botany,  
Indian Agric. Res. Inst.,  
New Delhi-12, October 18, 1963.

B. D. PATIL.  
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## REVIEWS

*Four Dover Books on Astronomy :*

**Celestial Objects for Common Telescopes.** By The Rev. T. W. Webb. Edited and Revised by Margaret W. Mayall. Volume I: *The Solar System*. Pp. 255. Price \$ 2.25. Volume II: *The Stars*. Pp. 351. Price \$ 2.25.

More than one hundred years after its original publication, this classic handbook is once again available for the use and pleasure of the amateur astronomer. The data collected in it will be of great value to the serious hobbyist and the scientist without access to large professional equipment, and will help in locating and identifying thousands of celestial objects. The first volume which deals with the solar system has been revised from the sixth edition of the original work. It begins with an introduction to the instrument and observer and discusses the principle and operation of the telescope and outlines procedures of observation and techniques of telescope-photography and spectroscopy. The rest of the volume gives precise location information for the sun, moon, comets, meteors, and the planets (except Pluto). The descriptions of planetary and lunar features are delightful and contain much of permanent value. The second volume which deals with the stars has been extensively revised and it contains the largest and finest collection available of celestial objects that can be viewed with moderate sized telescopes—nearly 4,000 objects in all. The constellations are listed alphabetically, and the descriptions include notes by many observers on such matters as the color of double stars and instruments used. Special attention is given to double stars, clusters, stars with unusual spectra, variables, and nebulae. For each object corrected location data for Epoch 1920 is given.

**Mathematical Theories of Planetary Motions.** By Otto Dziobek. Pp. 294. Price \$ 2.00.

In the first half of the book, the author covers elliptic, parabolic and hyperbolic orbits; the solution of Kepler's equation; the problem of  $n$ -bodies and the important special case of three bodies; Poisson's and Lagrange's formulas for the elliptic elements of the orbit of a planet; the canonical system of constants of integration; the partial differential equation of Hamilton and Jacobi; and other topics. Under the general heading of perturbation theory, which forms the latter half of the book, the author considers

the theory of absolute perturbations; analytical development of the perturbing function; analytical expressions for the perturbations; the variation of the elements; secular values of the elements and development of the rigorous equations between them; the secular variations of the mean longitude; the stability of the solar system; the invariability of the major axes; and many other closely related matters. Pertinent and interesting historical sketches accompany each important subdivision, and references to original sources of information are faithfully given.

**Statistical Astronomy.** By Robert J. Trumpler and Harold F. Weaver. Pp. 643. Price \$ 3.00.

The book opens with an extensive introduction to statistical theory. This section is, quite naturally, written to provide astronomers with the tools for solving problems of descriptive astronomy, observational errors, constitution of extra-galactic nebulae, etc. Pains have been taken to relate procedures used in statistical astronomy to such basic mathematical principles of statistics as univariate distribution, integral equations, general theory of samples, and methods of testing hypotheses. The second half of the book is devoted to the most important current application of statistics in astronomy: the study of the structure, constitution and dynamics of our own galactic star system. After a general analysis of the problem, there are rich and thorough discussions of the motion and distribution by physical characteristics of stars in the vicinity of the Sun. Then follows a detailed review of earlier work on star counts and of more modern methods by which the extinction effects of interstellar matter and the star density function may both be determined from statistical discussions of observational data. The final section presents the theory of galactic rotation and its verification by observation.

C. V. R.

**Malnutrition and the Eye.** By Donald S. McLaren. (Academic Press, New York and London), 1963. Pp. 390. Price \$ 15.50.

Clinicians, nutritionists and ophthalmologists should feel greatly obliged to Dr. McLaren for having placed at their disposal the first and the most exhaustive, critical and fully documented treatise on the various aspects of malnutrition

affecting the eye. As Dr. W. J. Darby says, "It is surprising that such a scholarly and critical treatise on the subject of nutrition and the eye has not previously appeared".

The book is divided into three principal parts: Part A deals with nutritional aspects of vision, Part B with malnutrition and its effects on the eye of experimental animals and Part C with human nutritional eye diseases.

Dr. McLaren begins his book with a masterly and concise treatment of the structure, development and growth of the eye, after which he thoroughly discusses the degenerative changes occurring in the eye due to a variety of experimentally induced dietary deficiencies in laboratory animals. The author also describes rather exhaustively the histological and pathological conditions concerning each anatomical part of the eye, as caused by these deficiencies. As for example, one chapter is devoted entirely to the effects of certain dietary carbohydrates on the metabolism of the lens, resulting in cataract, while congenital malformations arising out of maternal nutritional deficiency in experimental animals have been described in yet another chapter.

Over half of the book deals with human nutritional eye diseases, where the devastating effects of vitamin A deficiency and the undeniable fact that in spite of scientific advancement, a large proportion of the world population is unnecessarily rendered blind "due to the lack of a handful of vitamin A units" have been discussed effectively. The most significant aspect of this book is that the author has succeeded in bringing out very forcefully the immense magnitude of the problem of vitamin A deficiency among the human beings of the underdeveloped countries.

In Chapter 17, the author discusses a variety of techniques by which the nutritional status of the eye can be assessed. This particular chapter should provide a valuable guide to all scientific workers engaged in nutrition surveys.

Numerous photographs, both in colour and in black and white, augment the value of the book.

S. MAHADEVAN.  
J. GANGULY.

**Analytical Microbiology.** Edited by F. Kavanagh. (Academic Press, New York), 1963. Pp. xvi + 707. Price \$22.00.

The microbiologist has steadily improved the techniques available to him and has during recent years not only made much headway in devising methods in analytical microbiology but

has succeeded in using machines and instruments which increase the speed of his analysis and reduce the cause of the error at the same time. But as it often happens, some of the methods "hastily devised" by him "were based upon rudimentary theory" and had to undergo modifications in the light of theoretical considerations subsequently developed. It is against this background that this book was planned and in its first portion are provided "firm theoretical foundation for methods of assay", and in the second portion are detailed the specific methods of assay.

Written by investigators with long and diverse experience in the fields it brings together several related topics as (1) The Theory of Antibiotic Inhibition Zones, (2) Microbiological Assay using Large Plate Methods, (3) Dilution Methods of Antibiotic Assays, (4) Photometric Assay, (5) Antimicrobial Assays of Bacitracin, Cephalosporin C, Chloromphenicol, Erythromycin, Fumagillin Hygromycin B, Neomycin, Penicillins, Polymixin, Ristocetin, Streptomycin, Dihydrostreptomycin, Tetracyclines, Thiostrepton, Tylosin, Vancomycin, Amphotericin A, B and Nystatin. Likewise, microbiological assays of Biotin, Folic acid, Pantothenic acid, Inositol, Pyridoxine, Riboflavin, Thiamine, Vitamin B<sub>12</sub> and Congeners and of amino-acids are furnished. The material presented in the text is appropriately illustrated with tables, figures and photographs and the literature, coming upto as recent as 1962 papers, is listed at the bottom of the very page on which it is referred to.

The presentation of the subject-matter is clear and lucid and all senior students and investigators in the subject of Microbiology will be highly benefited by reading it. The reviewer welcomes this volume and recommends it warmly to all concerned.

J. V. B.

**Advances in Biochemistry.** Edited by P. S. Sarma, 1963. Pp. 449. Price (inclusive of postage) Rs. 15, \$5, 30 sh. Copies can be had from: The Registrar, Indian Institute of Science, Bangalore-12, India.

This impressive and well-brought-out volume edited by Prof. P. S. Sarma presents the Proceedings of the Summer School in Biochemistry held at Srinagar, Kashmir, India, in May-June 1962, in the form of a series of review articles. Thirty-four topics covering various fields of current research in biochemistry are included. Review in each field has been made with references up to 1961. At the end of the volume an appendix of about forty pages is

devoted to notes on methodology which will prove useful as a ready reference to persons working in biochemical estimations. The volume on the whole presents a fair idea of the work that is being done in India and highlights some of the significant results that have been obtained.

This publication will benefit all working biochemists and the very reasonable price fixed for it by the publishers should make it possible for individual workers to own a copy.

E. R. B.

**Mechanisms of Virus Infection.** Edited by Wiltson Smith. (Academic Press, London and New York), 1963. Pp. viii + 368. Price 80 sh.

A book of this type is one which is peculiarly difficult to evaluate since, as the editor states, it "is intended neither as a text-book nor as a work of reference for the expert".

The first chapter, by the editor, provides an introduction and a background for the following chapters. The various key features of the host-virus relationship and the current concepts of virus constitution and genetics are succinctly and clearly presented.

The next chapter on "The Bacteriophage Model" is the longest in the book and ably summarizes a vast amount of information in a logical and coherent fashion.

The third chapter considers the "Pathways of Virus Infection" from the standpoint of virus entry into the host, spread within the host, and release from the host body.

Three aspects of the "Mechanisms of Cell Infection" are discussed under the sequence in which the process occurs, namely, attachment and penetration, intracellular replication, and release.

A very lucid and interesting chapter on "Virus Pathogenicity" is followed by an account of "Virus Adaptability and Host Resistance" which ends the text.

The bibliography seems to have been chosen to give one desirous of reading further an easy access to the main body literature.

Since the subject-matter is largely concerned with those viruses producing infectious disease in warm-blooded vertebrates the title is slightly misleading. The chapter on the bacteriophages forms a necessary introduction to the general field of virus replication and genetics and is the only other group of viruses discussed to any extent. The most obvious omission is the group of tumour viruses.

The editor feared that the text would be some-

what uneven due to the different styles of the authors, but this did not seem to be a factor of significance to the reviewer. Although there is some repetition, it generally appears in different contexts and therefore does not detract from the general presentation.

The book would seem to be of most value to those working in other branches of virology and to graduate students. The most unattractive feature of the book is the price, which seems to be high for a book which is only timely and not primarily expected to serve as a reference.

CHARLES R. ANDERSON.

### Books Received

From: (Academic Press, 111, Fifth Avenue, New York-3):

*Progress in Chemical Toxicology* (Vol. I). Edited by A. Stolman, 1963. Pp. xii + 436. Price 100 sh.

*The Liver—Morphology, Biochemistry, Physiology* (Vol. I). Edited by Ch. Rouiller, 1963. Pp. xiii + 683. Price \$26.00.

*Advances in Immunology* (Vol. III). Edited by F. J. Dixon, Jr. and J. H. Humphrey, 1963. Pp. xi + 408. Price 93 sh.

*Advances in Clinical Chemistry* (Vol. VI). Edited by H. Sobotka and C. P. Stewart, 1963. Pp. xiv + 397. Price \$14.00.

*Plant Diseases—Epidemics and Control*. By J. E. Van Der Plank, 1964. Pp. xvi + 349. Price \$10.00.

*Advances in Inorganic Chemistry and Radiochemistry*. Edited by H. J. Emeleus and A. G. Sharpe, 1963. Pp. ix + 429. Price \$14.50.

*Advances in Computers*. Edited by F. L. Alt and M. Rubinoff, 1963. Pp. xii + 312. Price \$12.00.

*Atherosclerosis and Its Origin*. Edited by M. Sandler and G. H. Bourne, 1963. Pp. xiii + 570. Price \$22.00.

*The Transfer of Calcium and Strontium across Biological Membranes*. Edited by R. H. Wasserman, 1963. Pp. xvii + 443. Price \$11.50.

*Relativistic Fluid Mechanics and Magnetohydrodynamics*. Edited by Robert Wasserman and C. P. Wells, 1963. Pp. x + 241. Price \$8.50.

From: (Dover Publications, 180, Varick Street, New York-14, N.Y.):

*Crystallographic Data on Metal and Alloy Structures*. Compiled by A. Taylor and B. J. Kagle, 1963. Pp. 263. Price \$2.25.

*Mathematical Crystallography and the Theory of Groups of Movements*. By H. Hilton, 1963. Pp. xii + 262. Price \$2.00.



## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Chemistry to Shri L. S. A. Dikshitulu for his thesis entitled "Some New Aspects of Analytical Chemistry of Vanadium"; D.Sc. Degree in Geology to Shri G. Prabhakara Rao for his thesis entitled "Some Aspects of the Placer Deposits of South Kerala in relation to the Geomorphic Evolution of the West Coast of India"; D.Sc. Degree in Technology to Shri M. Sanyasi Reddy for his thesis entitled "Studies on Vapour-Liquid Equilibria of Binary and Ternary Systems".

M.S. University of Baroda has awarded the Ph.D. Degree in Zoology to Shri Damodhar Venkatraman Naik for his thesis entitled "Studies on Certain Metabolic and Neuroendocrinological Aspects of Bird Migration".

### Summer School in Oils and Fats

A Summer School covering *Recent Advances in the Chemistry and Technology of Oils and Fats* is being organised under the auspices of the CSIR at the Regional Research Laboratory, Hyderabad, between June 15 and 27, 1964.

Full information may be obtained from Dr. G. Lakshminarayana (Convener), Regional Research Laboratory, Hyderabad-9.

### XII International Spectroscopy Colloquium

The XII International Spectroscopy Colloquium, organised under the auspices of the British Spectroscopists Co-ordinating Committee in collaboration with The Institute of Physics and The Physical Society, will be held in the University of Exeter from 12 to 17 July 1965. The principal topics will be optical emission, absorption, X-ray and mass spectroscopy. Special attention will be given to chemical, metallurgical, medical and biological applications. Continuous process control, the detection of non-metallic impurities in metals will be some of the subjects of discussion.

All enquiries should be addressed to the Colloquium Secretary, Mrs. C. E. Arregger, F.M.S.P., 1, Lowther Gardens, Prince Consort Road, London, S.W. 7.

### Canadian Journal of Earth Sciences

The Canadian National Research Council has approved starting a new journal to publish work in the fields of the Earth Sciences. This

journal, to be known as *Canadian Journal of Earth Sciences*, is intended to perform the same function for the Earth Sciences as that provided by the existing journals for Chemistry, Physics, etc. Research papers in the Earth Sciences will, therefore, be welcomed by the Editor from workers in Canada and elsewhere.

The *Canadian Journal of Earth Sciences* will be published bimonthly and the first number is expected to come out next July.

Manuscripts should be sent to Dr. H. C. Gunning, 3192, West 44th Avenue, Vancouver 13, British Columbia, Canada, who is the Editor of the new journal.

### Geological Society of India—Publication of Research Bulletins

The Geological Society of India has decided to publish, apart from its Annual Journal which publishes long and complete papers, Quarterly Bulletins of current geological research in India. The first issue is expected to be published in June 1964.

The Bulletin is intended to give quick publicity to short communications and notes in Geology. Communications for publication in the Bulletin should not be more than about 1,500 words in length, and should be sent to the Editor, Prof. L. Rama Rao, "Shantiniketan", Basavangudi, Bangalore-4.

### Oxidation of Nickel Studied by Electron Field Emission

An electron field emission microscope (FEM) has been applied to a qualitative study of oxygen adsorption on nickel by W. J. Ambs of the National Bureau of Standards. During oxygen adsorption, the nickel emission patterns developed sharp bright rings around the (110) crystallographic planes, indicating that a rapid rearrangement of atoms was taking place in these areas.

The field emission microscope presents a direct method of observing the events occurring on a metallic surface; it gives an approximation to a stereographic map of the work function distribution of a hemispherical crystal surface. Hence, it reveals the presence of epitaxial layers, foreign particles, and, under certain conditions, individual adsorbed molecules. All changes which involve a local alteration of work function or local change in tip radius of the emitter

cause a change in the pattern. Since the useful magnification of the instrument is comparable with that of the conventional electron microscope, the FEM reveals events on an almost atomic scale, making it useful in the study of nucleation phenomena.

At an oxygen pressure of  $10^{-8}$  Torr and room temperature, the intensity of the emission pattern from nickel slowly decreased as oxygen was adsorbed on all planes. Simultaneously small, sharply defined bright rings centered on the (110) planes developed.

In preliminary experiments on iron, the phase transition at  $910^{\circ}\text{C}$ . was observed. Observation of this transition is considered remarkable because of the structural weakness of pure iron at this temperature and the extremely heavy stress placed on the emitter by the electric field.

In preliminary oxidation experiments on iron whiskers, a preferential darkening of the (111) planes was noted. It was also found that iron whiskers can be grown by heating iron field emitters to about  $900^{\circ}\text{C}$ . in the electric field.—(*Jour. Opt. Soc. Amer.*, 1964, 54, 283.)

#### New Laser Emits Photons and Generates Phonons in Crystal

Magnesium fluoride doped with nickel ions has been found to exhibit some unique laser properties. Johnson, Dietz and Guggenheim of Bell Telephone Laboratories report (see *Phys. Rev. Letters*, October 1, 1963) that this material in addition to emitting coherent infra-red laser light also generates vibrations (phonons) in the crystal lattice.

In the new laser, nickel ions are excited to high states of energy by optical pumping in the usual way, and they then relax back to the upper laser level. From this level, which is an electronic state of nickel in the magnesium fluoride lattice, the ions fall to the lower laser level, emitting the photon associated with laser action. At this lower level the nickel ions are in the ground state and, therefore, unexcited; but the lattice, on the other hand, is vibrationally excited.

In short, part of the energy of excitation is converted to vibrational energy by the generation of a phonon in the crystal lattice. The frequency of the laser oscillation is partly determined by the energy of this phonon. The larger the phonon energy, the lower the laser frequency. Thus the laser oscillation results not from a nickel ion transition alone, but from a transition of the crystal as a whole.

The reason laser oscillation does not occur in the purely electronic transitions of the nickel ions is that photons emitted at these shorter wavelengths tend to be absorbed in the crystal. The longer wavelength photons associated with the phonon generation are not absorbed so much, stimulate further emission. Thus, a magnesium fluoride crystal doped with nickel ions breaks into laser oscillation at a wavelength associated with the phonon generation and at a pumping power level much lower than would be required to cause laser action at the shorter wavelength associated with purely electronic transitions.—(*J. Frank. Inst.*, 1964, 277, 92.)

#### Supernova Electrons

Balloon observations at the University of Chicago and the Argonne National Laboratory have yielded the first experimental evidence to support the idea that cosmic rays originate in the explosions of supernovæ. The primary cosmic rays that reach the earth's atmosphere and give rise to 'showers' at the ground consist almost entirely of protons. Certain observations of radioastronomy have indicated, however, that also present in the primary cosmic radiation are large number of electrons. Two theories have been put forward to account for the electrons: that they arise in the collision of protons with hydrogen nuclei in interstellar space and that they are generated by supernovæ. The first process would produce roughly equal numbers of negative electrons and positrons; the second a preponderance of negative electrons.

In the experimental programme set up by the research group of Chicago University and Argonne National Laboratory, balloons were sent up on July 28 and August 5, 1963, each balloon remaining at an altitude of about 25 miles for more than 10 hrs. Camera carried aloft the balloons recorded 62,000 events or cosmic ray passages. A permanent magnet caused negative electrons and positrons to take up slightly different paths through the spark chambers that detected them.

The photographs revealed a ratio of three negative electrons to every positron. At higher energies, between 300 million and a billion electron volts, the ratio of negative electrons to positrons reached five to one. The figures are interpreted to mean that about half of all the primary cosmic ray electrons are from proton-proton collisions in space and half from supernovæ.—(*Sci. American*, February 1964.)

# THE EMISSION SPECTRUM OF S<sub>2</sub> MOLECULE\*

N. A. NARASIMHAM

*Spectroscopy Division, Atomic Energy Establishment, Trombay, Bombay, India*

IN the S<sub>2</sub> spectrum, only one band system in the region 2800-6500 Å has been known for a long time and studied in greater detail. This system involves transition from  ${}^3\Sigma_u^-$  to the ground state  ${}^3\Sigma_g^-$  of the molecule and is analogous to the Schumann-Runge bands of O<sub>2</sub>. Several fragmentary band systems, in the regions 6980-8100 Å and 2448-2850 Å, were obtained in a high frequency discharge through sulphur by Rosen and collaborators<sup>1</sup> who proposed some tentative analyses for the ultra-violet bands. High resolution studies of these bands were taken up three years ago with a view to identify their electronic transitions and correlate the electronic states with the ground state of the S<sub>2</sub> molecule. While these were in progress, short notes on some of these bands appeared proposing partial rotational analysis of a few of the infra-red bands<sup>2</sup> and a tentative vibrational assignment of the ultra-violet bands.<sup>3</sup> The present studies, however, are based on the rotational analysis of a larger number of bands photographed under high resolution and with an enriched <sup>34</sup>S isotope. The more salient points of these investigations are presented here while the details are submitted for publication elsewhere.<sup>4</sup>

## A. NEAR INFRA-RED BANDS OF S<sub>2</sub>

In the present investigation, the violet degraded near infra-red bands were excited in a 2450 mc./s. microwave oscillator discharge through sulphur vapour with helium as carrier gas. The bands were photographed on 3.4 m. and 6.6 m. grating spectrographs at dispersions of 5 Å/mm. and 1.1 Å/mm. respectively. The following results of the rotational analysis of the bands show that they form two systems of bands involving (i)  ${}^3\Pi_{gi} - {}^3\Delta_{ui}$  and (ii)  ${}^2\Pi_{gi} - {}^3\Sigma_u^+$ -transitions, the  ${}^3\Pi_{gi}$  being the common initial level for both the systems. Representative spectra of these systems are shown in Fig. 1.

(i) *The  ${}^3\Pi_{gi} - {}^3\Delta_{ui}$  system in the region 6983.8-7760.6 Å*—These bands show simple P, Q, R structure. The Q branch is the most intense while the R branch is comparatively weaker than the P branch (Fig. 1, a). There

is no appreciable combination defect observed in the relations  $\Delta_1 F(J)$  of the upper or lower state (right up to  $J=34$  above which predissociation wipes out the band) thus showing negligible  $\Lambda$ -doubling. Further, it is evident from the rotational structure that both odd and even rotational levels are present. This observation, assuming the emitter to be S<sub>2</sub>, suggests that the upper and lower states of the transition are degenerate states (e.g.,  $\Pi$ ,  $\Delta$ , etc.). The bands show roughly an intensity distribution in the P, Q, R branches characteristic of a transition from an initial  $\Pi$  to a final  $\Delta$  state. Only two groups of sub-bands ( ${}^3\Pi_{2g} - {}^3\Delta_{1u}$  and  ${}^3\Pi_{1g} - {}^3\Delta_{2u}$ ) are observed (see Fig. 1, b) and both show predissociations. In the first group, rotational lines of  $J \geq 34$  are absent (Fig. 1, a) while in the second group of sub-bands lines of  $J \geq 16$  are absent. The multiplet separation of the initial levels of the two groups of sub-bands is found to be 135 cm.<sup>-1</sup> (as shown from the following  ${}^3\Pi_g - {}^3\Sigma_u^+$  bands) which would place the third component  ${}^3\Pi_0$  above the observed predissociations. Hence transitions from the third component are not observed.

(ii) *The  ${}^3\Pi_{gi} - {}^3\Sigma_u^+$  system in the region 7433.6-8083.0 Å*—In this system also only two groups of bands are observed and both the transitions involve the common final  ${}^3\Sigma_u^+$ . Rotational analysis shows that the upper state combination differences coincide with alternate rotational term values of the initial state of the previous  ${}^3\Pi_{gi} - {}^3\Delta_{ui}$  system. Further, the two sub-states,  ${}^3\Pi_{2g}$  and  ${}^3\Pi_{1g}$ , show predissociations exactly at the same  $J$  values, viz.,  $J \geq 34$  for  ${}^3\Pi_{2g}$  and  $J \geq 16$  for  ${}^3\Pi_{1g}$ , thus confirming the identity of the initial state with the  ${}^3\Pi_g$  state of the  ${}^3\Pi_g - {}^3\Delta_u$  system. As in the previous system, the transitions from  ${}^3\Pi_0$  state is not observed for an identical reason.

For a  ${}^3\Pi$  (case a) —  ${}^3\Sigma$  system 9 branches are expected for each sub-band. However, in the present system not more than 5 branches were observed for each of them. Other branches appear to be very weak. To bring these out, it is therefore thought necessary to develop the bands more intensely. This will enable one to make a study of the relative intensities of the different branches observed.

\* Presented at the 29th Annual Session of the Indian Academy of Sciences, held at Nagpur, on December 22, 1963.

## B. ULTRA-VIOLET BANDS†

These bands were excited in sealed-off tubes containing a trace of sulphur and a few mm. of argon by a microwave oscillator discharge of 2450 mc./s. and photographed in the second and third orders of a 35 ft. concave grating at dispersions of 0.89 Å/m. and 0.66 Å/mm. Sulphur containing 44.4% of  $^{34}S$  was used to obtain bands due to  $^{34}S$   $^{32}S$  and  $^{34}S_2$  in addition to  $^{32}S_2$ .

2847 Å have been analysed for their rotational structure. They are found to involve transitions from different vibrational levels of an upper electronic state to successive vibrational levels of a common lower electronic state. Isotopic shifts observed for the bands at 2620 Å and 2760 Å indicate that they are the (5-1) and (2-0) bands of the system. The bands at 2449, 2495 and 2495 Å then fit in as 8-0, 9-0 and 10-0 bands in a common vibrational scheme.

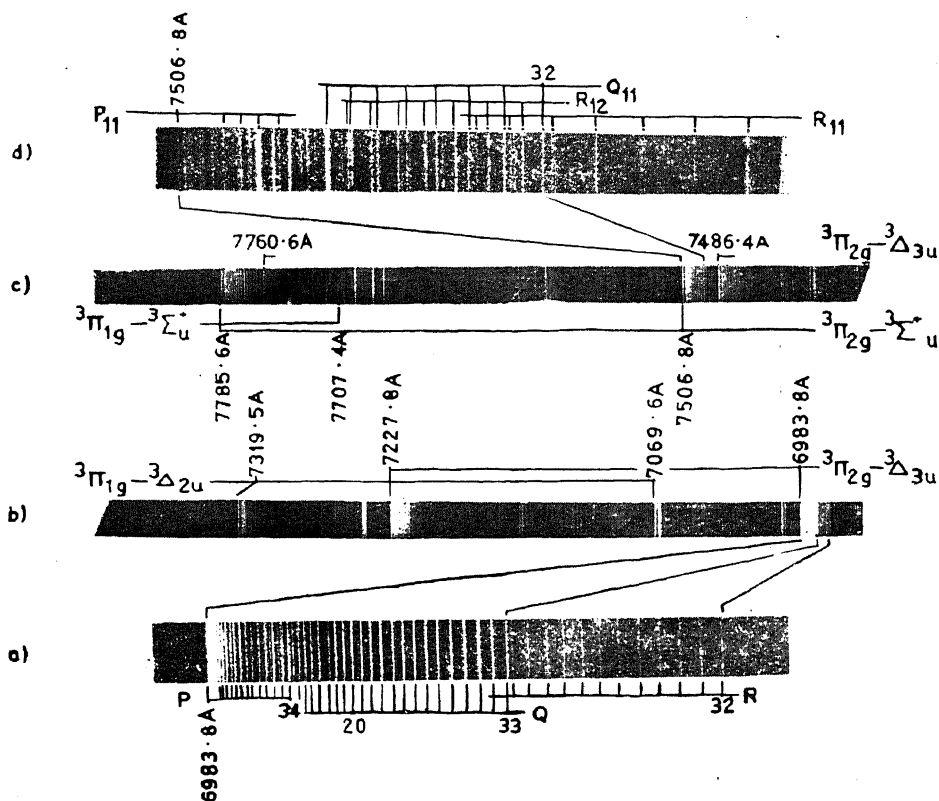


FIG. 1. Near infra-red bands of  $S_2$ . (b) and (c) Spectra taken on 3.3 m. Jarrell Ash grating spectrograph showing the  $3\Pi_{1g}-3\Delta_{2u}$  and  $3\Pi_{2g}-3\Sigma_u^+$  bands. (a) and (d) Rotational structure of the bands at 6983.8 Å and 7506.8 Å. Because of predissociation in the upper state  $3\Pi_{2g}$  rotational lines with  $J \geq 34$  are absent.

Rotational structure of the bands shows single series of P and R branches of both odd and even J values (Fig. 2). No staggering of the branches was found even at observed J values as high as 60. Further, in the bands due to  $^{34}S$   $^{32}S$ , there are no alternate lines missing. These observations support the assignment of the bands to a  $1\Delta_u-1\Delta_g$  transition. In all, six bands at 2620, 2660, 2760, 2793, 2813 and

In order to correlate the observed electronic states of the near infra-red and ultra-violet bands, it is instructive to consider the following electron configurations of  $S_2$ , starting from the groundmost one, and the corresponding electronic states.

$$(\sigma_g 2p)^2 (\pi_u 2p)^4 (\pi_g 2p)^2; \quad {}^3\Sigma_g^-, \quad {}^1\Delta_g, \quad {}^1\Sigma_g^+$$

$$(\sigma_g 2p)^2 (\pi_u 2p)^3 (\pi_g 2p)^3;$$

$${}^3\Sigma_u^+, \quad {}^3\Sigma_u^-, \quad {}^1\Sigma_u^+, \quad {}^1\Sigma_u^-, \quad {}^3\Delta_{ui}, \quad {}^1\Delta_u$$

$$(\sigma_g 2p) (\pi_u 2p)^4 (\pi_g 2p)^3; \quad {}^3\Pi_{gi}, \quad {}^1\Pi_g$$

† This part of the experimental work was carried out at the Argonne National Laboratory, U.S.A., in March-July 1961 during the author's stay.

$^3\Sigma_g^-$  is the ground state of  $S_2$ . The lower state of the ultra-violet bands ( $^1\Delta_g$ ) has a vibrational frequency nearly equal to that of  $^3\Sigma_g^-$  state and hence may be regarded to arise out of the same ground state electron configuration (1). The other three states, viz.,  $^1\Delta_u$ ,

The relative positions of these electronic states with respect to the ground state are yet not known. Further work, in absorption and emission of  $S_2$  which is in progress, is expected to throw more light on the electronic structure of  $S_2$  in its ground and excited states.

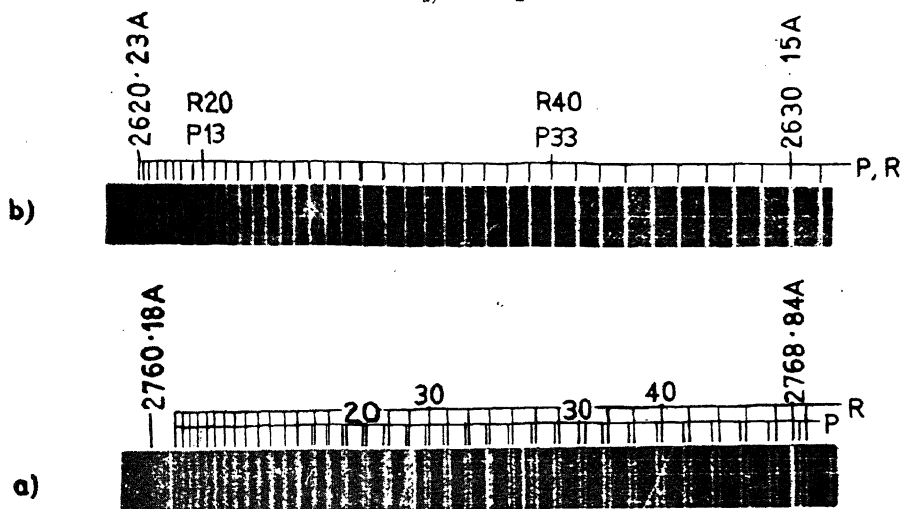


FIG. 2. Ultra-violet bands of  $S_2$ .

$^3\Delta_u$ ,  $^3\Sigma_u^+$  involved in the present ultra-violet and infra-red band systems have vibrational frequencies agreeing closely with that of  $^3\Sigma_g^-$  the initial state of the well-known extensive bands of  $S_2$ . Hence they may all be regarded as arising out of configuration (2). The initial level of the infra-red bands, which is a  $^3\Pi_{gi}$  state may correspond to configuration (3).

1. Rosen, B. and Bouffieux, F., *Bull. Acad. Roy. Belg. Cl. Sc.*, 1936, **22**, 885.  
— and Desirant, M., *Bull. Soc. Roy. Sc. Liegi*, 1935, **6-7**, 233.
2. Meakin, J. E. and Barrow, R. F., *Can. J. Phys.*, 1962, **40**, 377.
3. Haranath, P. B. V., *Z. Phys.*, 1963, **173**, 428.
4. Narasimham, N. A. and Sethuraman, V., *Proc. Ind. Acad. Sci.* (In press).  
— and Brody, J. K., *Ibid.* (In press).

## NEW MINIATURE GAS LASER

A MINIATURE helium-neon gas laser that emits only a single frequency of visible red light has been devised at Bell Telephone Laboratories. The length of its discharge tube is only two inches, its diameter is 0.04 inch and it operates continuously at room temperatures on direct current. The frequency of oscillation is very stable and the power of the emitted coherent light is comparatively high for the laser's small size.

By varying the spacing between the end mirrors of the laser cavity, the laser was made to oscillate at any one frequency within a 1,500 megacycle range centred at 473,000 kilo mega-

cycles. To tune the laser over this frequency range, one of the end mirrors need be moved less than 12-millionths of an inch. This can be accomplished smoothly and precisely with a piezoelectric transducer attached to one mirror.

The combination of stability plus single frequency oscillation is very useful in that the laser can act as a very precise measuring instrument. If one of the mirrors is connected to a positioning device, very slight changes in position will cause the laser to shift frequency. Displacements considerably less than one-millionth of an inch can be detected and, with an oscilloscope, readily measured.—(*Jour. Frank. Inst.*, 1964, **277**, 178.)

A NEW METHOD OF FRACTIONATION OF LAC RESIN AND THE  
PREPARATION OF ALEURITIC ACID

R. MADHAV, T. R. SESHADRI AND G. B. V. SUBRAMANIAN

Department of Chemistry, University of Delhi, Delhi-6

DURING the course of our investigation<sup>1</sup> on the components of the lac resin it was found that preliminary fractionation of the material was desirable in order to deal with the complex mixture of components present. The earlier separation into the ether-soluble soft resin and the ether-insoluble hard resin, widely employed by most workers, still leaves each subsequent fraction as a very complex mixture. The literature shows only one extensive attempt by Schaeffer and co-workers,<sup>2</sup> to further fractionate shellac by solvents, before chemical degradation.

Many difficulties of a physico-chemical nature are encountered in the fractionation of the resin. The tendency to form solid solutions and colloidal aggregates is considerable. The result has been the presence of some of the more soluble fraction in the less soluble fractions due to incomplete removal at earlier stages. Consistency in the nature of the resulting fractions is also dependent on the nature of the host-insect specificity, the structural variations on storage and the preliminary treatment the resin has undergone. Extensive precautions were taken by Schaeffer *et al.* to avoid or minimise these difficulties. Their starting material was finely powdered seedlac of the kusum variety obtained from the Khair host (*Acacia catechu*). The material was mixed with filter-aid and extracted at room temperature. Yet their final results indicate the possibility of incomplete initial extraction with chloroform, the consequence of which appears to be the distribution of the same components into different fractions. For example, KIIA and KIIB of their fractions have considerable resemblance to fractions KIA and KIB.

Instead of following a procedure of selective extraction as described by them, we have employed the reverse procedure of fractional precipitation of the total extract. The starting material employed in the present series of experiments was the seedlac obtained from the host tree, Palas (*Butea monosperma*). Extraction of the finely powdered material with light petroleum at 30-40° removed a major part of the waxes as a soluble fraction. This preliminary extraction of the waxes which are insoluble in cold alcohol has been found useful since the subsequent treatment with cold alcohol effec-

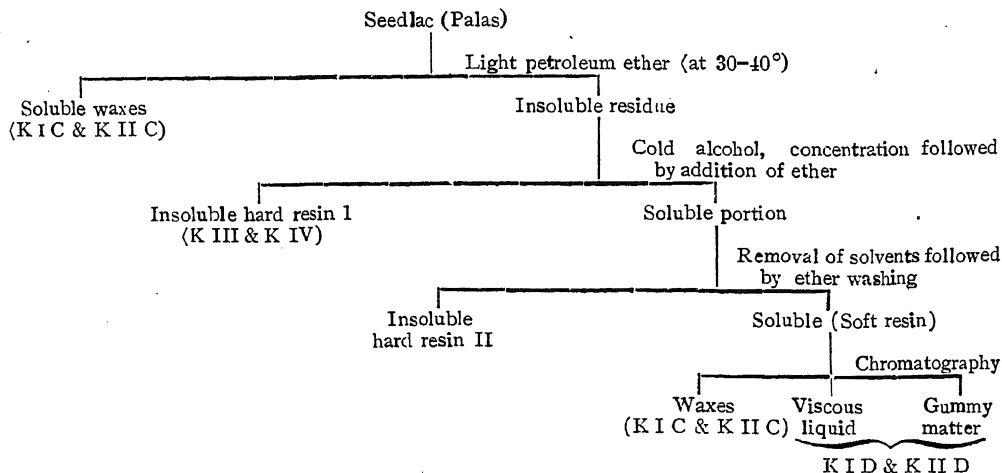
tively extracted all the remaining resin. When the clear solution of the extract was cooled to 0° a further small amount of wax separated out. The filtered alcoholic solution was then concentrated under reduced pressure to a small bulk and the concentrate was poured into a large volume of ether with continuous vigorous stirring. The precipitated hard resin on similar treatment repeatedly gave an amorphous powder (hard resin I) which was soluble in acetic acid, alcohol and acetone but insoluble in ethyl acetate, ether, chloroform and benzene. The alcohol-ether solution was distilled under reduced pressure until all the solvents were removed. The residual gum on repeated maceration with ether gave a powdery mass (hard resin II) which was soluble in acetic acid, alcohol, acetone and hot ethyl acetate and largely in hot chloroform but insoluble in ether and benzene.

The ether solution on evaporation gave a red gummy residue which did not solidify. This fraction should represent the conventional soft resin. It was completely soluble in the solvents listed above with the exception of hot benzene in which about 50% dissolved and hot light petroleum, in which only a small part dissolved. All the colouring matter was present in this fraction. By column chromatography on charcoal the colouring matter was adsorbed and the other components eluted into fractions. The first eluate with ethyl acetate was the wax (m.p. 84°) followed by a colourless viscous liquid and finally a colourless gummy matter which was removed from the column by hot acetic acid.

Table I sums up the details of the procedure. The comparable fractions reported by Gardner *et al.* are also given.

The scheme below offers some advantages over the one described by Gardner. The process is less laborious and the chances of incomplete extraction at the solid-liquid interface is avoided, thereby effecting a more rigorous separation. Each fraction is well defined in terms of its solubility. However, each one is a mixture by itself and no correlations can be made on their yields since the nature of the starting material varies considerably, particularly on storage. The markedly polymeric nature of the fractions soluble only in polar solvents as compared to

TABLE I



those that are soluble in non-polar solvents as well, has been demonstrated by the American workers from the molecular weight data, acid number, saponification number and ester number.

An earlier note<sup>1</sup> describes a method of degradation of hard resin by fission with hydriodic acid and red phosphorus at 115° in acetic acid solution. The products were separable into an iodinated fatty acid part and an iodinated terpene part. Reduction of the iodinated fatty acid mixture with zinc amalgam and acid gave the straight chain saturated acids. Purification through column chromatography on alumina followed by paper chromatography showed it to contain palmitic acid to an extent of 95% of the total fatty acids. The experiments reported in that note were carried out with hard resin I. The conclusions drawn were that hard resin I does not contain any appreciable amounts of other chain lengths and no dicarboxylic acid. However, these series of experiments do not give any evidence on the hydroxylation pattern in the palmitic acid chain. It is therefore desirable to get further idea of the number and nature of the hydroxy fatty acids present in the hard resin.

The only hydroxy acid that has been well characterised is threo aleuritic acid (9 : 10 : 16-trihydroxy palmitic acid) obtained by the alkaline hydrolysis of the total resin to an extent of 20% in general though one worker<sup>3</sup> claimed about 43%. The major difficulty involved in the use of the alkaline hydrolysis method is the lack of a suitable method of complete separation of the hydroxy fatty acids and the terpene acids from the reaction mixture, due to closely similar

properties. This difficulty has now been partially overcome by the initial treatment of the hard resin, with hydrogen chloride gas in acetic acid solution with the formation of chlorine containing oily resin. Alkaline hydrolysis of this oil gave a gummy mass from which the sparingly soluble erythro aleuritic acid could be easily separated out by treatment with ether and the ether solution yielded the terpene acids as a viscous liquid along with other minor components. The yields of crude erythro aleuritic acid from different samples are given in Table II. In all cases the product was fairly pure and yielded readily on recrystallisation more than 75% of it as pure erythro aleuritic acid.

TABLE II

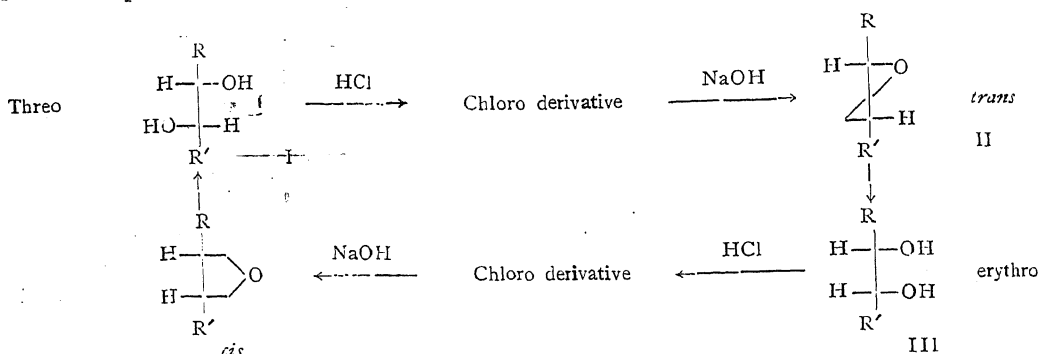
*Erythro aleuritic acid from different types of lac*

	Approx. yield %
Hard resin I (from Palas Seedlac)	.. 30-35
Hard resin II ( " )	.. 25
Platina shellac	.. 30-35
Lemon shellac	.. 40
Angelo Superblonde shellac	.. 40

In the earlier note (*loc. cit.*) we showed that from hard resin I, an amount of pure palmitic acid was obtained which would correspond to about 40% aleuritic acid, assuming that all the C<sub>16</sub> acid is aleuritic. However, employing the same type of sample there is some loss of the hydroxy fatty acids in the present series of experiments. This result may be due to the presence of other C<sub>16</sub> hydroxy acids as well as

to the experimental loss during the processing of the reaction products.

yields an oily chlororesin which on further alkaline hydrolysis yields as final product only



In order to understand the scope of the method, model experiments have now been carried out with threo aleuritic acid (I) obtained by the alkaline hydrolysis of the resin. Conversion into the chloro derivative by treatment with hydrogen chloride gas, followed by alkaline hydrolysis, yielded a mixture of the *trans*-epoxide (II) and erythro aleuritic acid (III). The epoxide was not obtained analytically pure. However it gave erythro aleuritic acid on ring opening with acetic acid followed by alkaline hydrolysis of the acetoxy ester. The erythro acid in turn gave a mixture of the *cis*-epoxide (IV) and the threo acid by a similar series of experiments. The conversion of the threo acid into erythro acid involves three inversions<sup>4</sup> one at each stage as indicated below.

Summarising the results, alkaline hydrolysis of the resin yields entirely threo acid and no erythro acid. On the other hand initial treatment of the resin with hydrogen chloride gas

erythro and no threo aleuritic acid. Obviously the extra preliminary treatment has caused this difference and this change is useful for separation of acids. It would appear that only one configuration of the aleuritic acid partakes in the resin formation. It has been further noted in the course of the present work that no optical activity was exhibited by the epoxide or the erythro aleuritic acid.

#### ACKNOWLEDGEMENTS

The authors express their grateful thanks to the Director, Indian Lac Research Institute, for providing the lac samples.

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## RADIOCARBON DATES OF ARCHAEOLOGICAL SAMPLES

D. P. AGRAWAL, S. KUSUMGAR AND R. P. SARNA

Tata Institute of Fundamental Research, Bombay-5

**I**N this paper are presented further radiocarbon dates of several archaeological samples obtained by procedures described earlier in some detail (Kusumgar et al., 1963 a). The synthesis of acetylene from the sample's carbon was preceded by several physical and chemical steps to remove carbon extraneous to the sample. Mud grains, rootlets and other objects were first removed. The decomposable carbonates present due to admixture of soil, and *in situ* passage of ground water, were removed by digestion with a hot solution of 3% hydrochloric

acid. Humic acid was separated by treatment with a hot solution of 1% NaOH. If the sample was soft, the NaOH treatment often disintegrated the sample itself. This step was therefore avoided in some cases. Since this is an important step for cleaning sample off its incorporated humic acid and disintegrated rootlets, we have mentioned this pretreatment whenever followed in the date list presented here.

Radiocarbon dates are based on a value of 95% net activity of NBS oxalic acid, as the age-corrected value for pre-1900 wood (Godwin,



1959). Two dates are given for each sample. The first date is based on the value of  $5568 \pm 30$  yrs. for the half-life of radiocarbon; the second date, given within paranthesis, is calculated on the basis of the half-life value,  $5730 \pm 40$  yrs., which seems to be a better working value. All intercomparisons of dates should be based on one particular half-life value only. All dates given are in yrs. B.P.; for converting them to A.D./B.C. scale, 1950 A.D. should be used as reference year (Flint *et al.*, 1962).

The sites from where the samples\* derived have been arranged in an alphabetical order. Where more than one sample was measured from the same site, the samples have been described in the order of increasing archaeological ages. Approximately contemporary samples have been arranged on the basis of increasing  $C^{14}$  dates only.

#### A BRIEF DISCUSSION OF DATES†

With the dates presented here, a total of about three dozen dates are now available for Harappan and Pre-Harappan sites extending from Damb Sadaat to Lothal. These suggest a total timespread of ca. 2300-1750 B.C., for the Harappan chronology (Agrawal, 1964). New measurements, for Rojdi and Lothal (TF 199, 200, 133, 135, 138, this date list), also confirm the same date bracket.

Painted Grey Ware has a special position in Indian archaeology because of its suggested equation with the Aryans. The charcoal samples dated from the P.G. Ware levels (Period II) of Hastinapur belonged to the uppermost two layers, *viz.*, 26 and 27. Of the five measured dates, three for 26th layer fall in the fourth century B.C.; two for the 27th layer in the sixth century B.C. The sample TF-191,  $2975 \pm 110$ , from the earliest P.G. Ware levels of Atranjikhhera places the beginning of this ware at ca. 1000 B.C.

#### ACKNOWLEDGEMENTS

The authors express their gratitude for the guidance received throughout this work from Prof. D. Lal. Thanks are also due to Shri B. K. Thapar for archaeological discussions.

\* Samples for radiocarbon dating are accepted by the Radiocarbon Laboratory of the Institute which has been set up primarily as a national facility for archaeological research. All enquiries should be addressed to the Secretary, Radiocarbon Dating Committee, Tata Institute of Fundamental Research, Colaba, Bombay-5.

† Discussion is based on the dates calculated on  $\tau_{1/2} = 5730$  yrs.

#### $C^{14}$ DATES WITH SAMPLE DESCRIPTIONS

##### Atranjikhhera, Uttar Pradesh, India

TF-191, Period II,  $2890 \pm 105$  ( $2975 \pm 110$ )

Charcoal sample (mixed with earth) from Atranjikhhera (Lat.  $27^\circ 42' N.$ , Long.  $78^\circ 44' E.$ ), District Etah. Trench ARJ4-D1, top of south-west corner, Depth 3.20 m., Layer 6, submitted by Nurul Hasan. The sample belongs to the earliest levels of P.G. Ware.

##### Dwarka, Gujarat, India

TF-173, Medieval Culture,  $310 \pm 90$  ( $320 \pm 95$ ),

Charcoal from Dwarka (Lat.  $22^\circ 15' N.$ , Long.  $69^\circ E.$ ), District Jamnagar. The sample is from Trench A, Locus  $3.40 \times 1.50$  m., Depth 1.45-1.50 m., Layer 3, Field No. 119. Dr. H. D. Sankalia, Deccan College, Poona-6, submitted the sample. Visible rootlets were hand-picked.

##### Hastinapur, Uttar Pradesh, India

Hastinapur (Lat.  $29^\circ 9' N.$ , Long.  $78^\circ 3' E.$ ), the legendary capital of Pandavas, is situated on the left bank of Ganga River in Meerut District. The site was excavated by B. B. Lal in 1950-52 (Lal, 1954-55) and 1962. Samples submitted by A. Ghosh.

The three dates presented below are in conformity to the five dates reported earlier (Agrawal *et al.*, 1964).

TF-81, Period III,  $2015 \pm 95$  ( $2075 \pm 100$ )

Charcoal sample (mixed with earth) from Trench HST-1/1962, Locus XC-XCIV, Layer 18, Depth 5.1 m. below surface, Field No. HST/62/C/2. Visible rootlets were hand-picked. NaOH pretreatment was also given.  $CO_2$  was evolved by wet combustion method. The sample derives from the uppermost layer of Period III, marking the end of Northern Black Polished Ware. Compare with TF-80, 82.

TF-112, Period II,  $2260 \pm 95$  ( $2325 \pm 100$ )

Bone sample (coated with earth) from Trench HST-1/1962, Locus XC'-XCVII', Layer 26 and Pit Y sealed by Layer 25, Depth 6.8 m. below surface, Field No. HST/62/C/7. Only the inorganic fraction was dated. The sample derives from the latest layer of Period II and will date the flooding of the site which led to its desertion by P.G. Ware using people.

TF-91, Period II,  $2450 \pm 120$  ( $2520 \pm 125$ )

Charcoal sample (mixed with earth) from Trench HST-1/1962, Locus XCIV-XCVII, Layer 27, Depth 6.9 m. below surface, Field No. HST/62/C/18. Visible rootlets were hand-picked. The sample derives from late levels of Period II.

**Hathinia Hill Baira, Uttar Pradesh, India**TF-109, Ash Pit,  $30 \pm 90$  ( $30 \pm 95$ )

Charcoal (mixed with earth) from the Megalithic site of Hathinia Hill Baira, Varanasi District of U.P. Sample derives from Trench KKR-A1, Locus III-IV, Pit A sealed by Layer 1, Depth 1.09 m. below surface, Field No. HAH/63/KKR-2. Visible rootlets were hand-picked. NaOH pretreatment was also given. As Pit A was disturbed by a recent pit, the excavators were doubtful about its association with the megalithic habitation. But since this was the only sample which was adequate for  $C^{14}$ -measurement, it was taken up for dating. The site was excavated by the Institute of Archaeology of Allahabad University under the supervision of its Director, Prof. G. R. Sharma, who submitted the samples.

**Kalibangan, Rajasthan, India**

The twin mounds of Kalibangan (Lat.  $29^{\circ} 25' N.$ , Long.  $74^{\circ} 05' E.$ ), District Sri Ganganagar, are located on the banks of Ghaggar (now dried). The site was identified as belonging to Harappa Culture by A. Ghosh. Excavations are being conducted, under the joint supervision of B. B. Lal and B. K. Thapar, since 1960-61. Submitted by A. Ghosh.

TF-150, Harappa Culture,  $3740 \pm 100$  ( $3850 \pm 105$ )

Charcoal (mixed with earth) from Trench KLB-2, Locus ZE 1, Qdt. 4, Layer 6, Depth 1.35 m. below surface, Field No. KLB-2, ZE 1/C/1962-63-16. NaOH pretreatment was also given. Sample belongs to the late levels of Harappa Culture at the site.

TF-139, Harappa Culture,  $3775 \pm 100$  ( $3880 \pm 105$ )

Charcoal (mixed with earth) from Trench KLB-2, Locus XA 8, Qdt. 2, Layer 6, Depth 0.95 m. below surface, Field No. KLB 2, XA 8/C/1962-63-2. NaOH pretreatment was also given. Sample derives from the middle levels of Harappa Culture at the site.

TF-151, Harappa Culture,  $3800 \pm 100$  ( $3910 \pm 105$ )

Charcoal (mixed with earth) from Trench KLB-2, Locus E 1, Qdt. 1, Layer 17, Depth 3.10 m. below surface, Field No. KLB-2, E 1/C/1962-63-17. Sample belongs to the middle levels of Harappa Culture at the site.

TF-147, Harappa Culture,  $3865 \pm 100$   
( $3980 \pm 105$ )

Charcoal (mixed with earth) from Trench KLB-2, Locus E 1, Qdt. 1, Layer 23, Depth 00 m. below surface, Field No. KLB-2, E 1/C/62-63-13. NaOH pretreatment was also given.

Sample is from the lower middle levels of Harappa Culture at the site.

TF-145, Harappa Culture,  $3895 \pm 100$  ( $4010 \pm 105$ )

Charcoal (mixed with earth) from Trench KLB-2, Locus XA 8, Qdt. 3, Layer 14, Depth 2.25 m. below surface, Field No. KLB-2, XA-8/C/1962-63-10. NaOH pretreatment was also given. Sample derives from the lower middle levels of Harappa Culture at the site.

**Kausambi, Uttar Pradesh, India**

Kausambi (Lat.  $81^{\circ} 23' N.$ , Long.  $25^{\circ} 20' E.$ ), modern Kosam, is situated on the northern bank of Yamuna. According to the Puranas, the capital of the Pandavas was shifted from Hastinapur to Kausambi at the time of Nichaksu. The measured samples cover Periods III and IV of the site (Sharma, 1960). The site is being excavated every year since a decade by the Allahabad University under the direction of Prof. G. R. Sharma who submitted these samples.

TF-98, Period IV,  $1470 \pm 90$  ( $1515 \pm 95$ )

Charcoal (mixed with earth) from Trench KSB-G/R-E 6, Locus XXXIII-XXXIV, Pit sealed by Layer 2, Depth 1.25 m. below surface, Field No. KSB/63/GR-101. Visible rootlets were hand-picked. Sample is derived from the debris of Huna invasion.

TF-94, Period IV,  $1945 \pm 90$  ( $2000 \pm 95$ )

Charcoal (mixed with earth) from Trench KSB-I-III-RD, Locus 4-5, Road VI, Depth 1.33 m. below surface, Field No. KSB/63/AP-2. Visible rootlets were hand-picked.

TF-95 Period IV,  $1840 \pm 115$  ( $1900 \pm 120$ )

Charcoal (mixed with earth) from Trench KSB-I-III-RD, Locus 4-6, Road V, Depth 1.44 m. below surface, Field No. KSB/63/AP-3. Visible rootlets were hand-picked.

TF-96, Period IV,  $2005 \pm 95$  ( $2065 \pm 100$ )

Charcoal (mixed with earth) from Trench KSB-I-III-RD, Locus 4-6, Road IV, Depth 2.03 m. below surface, Field No. KSB/63/AP-4. Visible rootlets were hand-picked.

TF-100, Period III,  $2160 \pm 95$  ( $2225 \pm 100$ )

Charcoal (mixed with earth) from Trench KSB-G/R-YZ 2, Locus 1-2, Pit A sealed by Layer 18 A, BK, Depth 2.15 m. below surface, Field No. KSB/63/GR-103. Visible rootlets were hand-picked. Sample derives from the last phase of N.B.P. Ware from Ghositarama area.

**Lothal, Gujarat, India**

Lothal (Lat.  $22^{\circ} 31' N.$ , Long.  $72^{\circ} 15' E.$ ), a Harappan site in Ahmedabad District, has

become famous for its ancientmost dockyard of the world. Six radiocarbon dates (Kusumgar *et al.*, 1963 b) for the III-V phases of the site give a range from ca. 2000-1800 B.C. The samples reported below were of charcoal powder mixed with earth and were wet combusted, so the probability of contamination by younger carbon is greater.

TF-133, Harappa Culture,  $3740 \pm 110$   
(3845  $\pm$  115)

Charcoal (mixed with earth) from Trench SRG 2, Locus AX 33, Layer 6, Depth 1.37 m., Field No. 75. CO<sub>2</sub> was evolved by wet combustion. The sample belongs to late phase II, Period A.

TF-135, Harappa Culture,  $3405 \pm 125$   
(3505  $\pm$  130)

Charcoal (mixed with earth) from Trench SRG 2, Locus AX 33, Layer 9, Depth 2.5 m., Field No. 77. CO<sub>2</sub> was evolved by wet combustion. The sample belongs to the early levels of phase II, Period A.

TF-136, Harappa Culture,  $3915 \pm 130$   
(4030  $\pm$  135)

Charcoal (mixed with earth) from Trench SRG 2, Locus AX 33, Layer 10, Depth 3.0 m., Field No. 78. CO<sub>2</sub> was evolved by wet combustion. The sample belongs to the late levels of phase I, Period A.

#### Rojdi, Gujarat, India

Rojdi (Lat. 21° 51' N., Long. 70° 54' E.) is situated on the Bhadar River in Rajkot District. The excavations at the site were started by P. P. Pandya and later resumed by J. M. Nanavati. There has been some controversy regarding the chronological position of Rojdi vis-a-vis Lothal and Rangpur. Radiocarbon dates agree with the equation of Lothal III B with Rojdi IB, as suggested by Nanavati.

TF-200, Harappa Culture,  $3810 \pm 110$   
(3920  $\pm$  115)

Charcoal (mixed with earth) from Trench B/5, Locus VII-IX, Layer 3, Depth 65 cm., Field No. Mound I/Trench B/5. NaOH pretreatment was given. The sample belongs to the sub-phase B of Period I, which is comparable to Lothal phase III B.

TF-199, Harappa Culture,  $3590 \pm 100$   
(3695  $\pm$  105)

Charcoal (mixed with earth) from Trench C, Pit 2 sealed by Layer 4, Depth 1.75 m., Field

No. Mound III/Trench C/4. Visible rootlets were hand-picked. NaOH pretreatment was also given. The sample belongs to the sub-phase B of Period I which is comparable to Lothal Phase III B.

#### Utnur, Andhra Pradesh, India

Utnur (Lat. 16° 0' 40" N., Long. 77° 38' E.), Mahbubnagar District, is a famous neolithic site of the Deccan excavated by Dr. F. R. Allchin in 1957 (Allchin, 1961). His excavations finally solved the problem of ash-mounds by connecting them with the activity of neolithic man thus vindicating Foote's precocious theories. The dates reported below are for the early neolithic levels, which are archaeologically little younger (Allchin, 1964) than those dated by BM-54 (Barker and Mackey, 1960). Thus the beginning of the neolithic culture of Deccan has now been firmly put at the close of the third millennium B.C.

TF-168, Neolithic Culture,  $3875 \pm 110$   
(3990  $\pm$  115)

Charcoal (mixed with earth) from Site I, Square D, Layer 5, Depth 75 cm. The sample belongs to Period III A (early Neolithic) and is archaeologically little younger than the levels dated by TF-167.

TF-167, Neolithic Culture,  $3890 \pm 110$   
(4000  $\pm$  115)

Charcoal (mixed with earth) from Site I, Square E, Layer 7, Depth 1.40 m. Visible rootlets were hand-picked. The sample belongs to Period II A (early Neolithic) and is archaeologically little younger than the levels dated by BM-54,  $4250 \pm 155$ .

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## LETTERS TO THE EDITOR

A NEW METHOD FOR THE  
PREPARATION OF QUINHYDRONE

IN the course of our systematic study of oxidation of aromatic compounds by persulphate ion, we observed that hydroquinone reacts with potassium persulphate in aqueous solution with the separation of the crystals of quinhydrone. This led us to suggest a new and simple method for the preparation of quinhydrone. This compound is very greatly used for setting up the quinhydrone electrode in potentiometric work and is commonly prepared by the oxidation of hydroquinone by ferric alum (Vogel<sup>1</sup>), the yield being about 15 gm. from 25 gm. of hydroquinone. The quinhydrone obtained by this ferric alum method contains traces of iron as impurity. However, we find that the method proposed by us firstly gives a better yield and secondly the product obtained is almost analytically pure.

**Method.**—Dissolve 20 gm. of A.R. Potassium persulphate in 100 ml. of water at about 60–70°C. Add this solution with stirring into a solution of 15 gm. of pure hydroquinone in 75 ml. of hot water contained in a 500 ml. beaker. The precipitation of quinhydrone starts almost immediately. Allow the beaker to stand at room temperature for about half an hour, then cool it in ice-water for another half an hour which helps in the complete separation of quinhydrone as green needle-like crystals with a metallic lustre. Filter under suction and wash the precipitate 3–4 times with cold water. Dry the product first by pressing between the folds of a filter-paper and then in a desiccator overnight. Yield: 13.6 gm.; m.p. of the product obtained: 171°C.

One of the authors (K. C. Khulbe) is grateful to C.S.I.R., New Delhi, for the award of a Senior Research Fellowship to undertake this work.

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A NEW METHOD OF PREPARATION  
OF CHLORINE TRIFLUORIDE

IN 1930, Ruff and Crug prepared chlorine trifluoride by the direct reaction between the elements.<sup>1</sup> The present authors have noticed the formation of chlorine trifluoride, when a mixture of sodium fluoride and sulphurmonochloride is refluxed. A brief communication regarding its preparation is given below.

A mixture of 20 gm. of sodium fluoride was refluxed with about 30 ml. sulphurmonochloride at 136°C. for about four hours with continuous stirring. The evolved gas was flushed in a current of dry nitrogen, condensed in a trap cooled by liquid air to a white solid, after passing through two traps cooled by freezing mixture. This was purified by fractionation to remove any sulphur chloride contamination as follows. The white product was allowed to evaporate and was then flushed by a current of nitrogen through traps cooled to –80°C., –121°C. and –176°C. respectively. Most of the substance condensed to a white solid in the trap cooled at –120°C. and there was very little deposit in the liquid air trap. The white product obtained in the –120°C. trap was absorbed in alkali. The analysis of this hydrolyzed product indicated the presence of chloride, fluoride and traces of sulphite. The sulphite was perhaps due to traces of sulphur halides present as an impurity in the product. The ratio of chlorine to fluorine in the alkali hydrolysed product was found to be 1 : 3 corresponding to a molecular formula for the gaseous product to be ClF<sub>3</sub> as shown in Table I. The residue in the reaction flask was found to be sulphur, sodium chloride and unreacted sodium fluoride and sulphur chloride. The yield of the product varied from 20 to 45% calculated on the basis of sodium fluoride used.

TABLE I

No.	Fluorine in gm. atoms $\times 10^3$	Chlorine in gm. atoms $\times 10^3$	F/Cl ratio	Sulphur in gm. atoms $\times 10^3$
1	7.534	2.43	3.1	0.020
2	5.091	1.654	3.06	0.016
3	3.119	0.977	3.192	0.112
4	4.582	1.470	3.117	0.009

Further evidence for the fluorinating capacity of the gas was obtained by the formation of

cobalt fluoride and silver fluoride when the gas was passed over the corresponding heated metallic chlorides.

The authors are highly thankful to Prof. A. R. Vasudeva Murthy for his keen interest and encouragement.

Department of Inorganic S. R. SATYANARAYANA.  
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### STUDIES ON DEFLUORIDATION OF WATER USING SULPHONATED GROUNDNUT SHELL CARBON

It was reported by several workers<sup>1-3</sup> that the presence of high fluoride content in drinking water in certain districts of Madras State was responsible for bone disease known as skeletal fluorosis. Various methods were tried by different workers for removal of fluorides from drinking water.<sup>4-7</sup> The method described in this communication is the same as that adopted by Mohanrao and Pillai<sup>7</sup> with suitable modifications.

**Preparation of Ion-Exchange Carbon.**—Dried groundnut shell,  $\frac{1}{2}$ " size, was carbonised in a low temperature muffle furnace at 300-350° C. for 2 hours. Weighed quantity of the carbon was then mixed with twice the amount of concentrated sulphuric acid in a beaker. The sulphonation was completed by keeping the contents at 100° C. for 5 hours in a thermostatically controlled oven. After keeping overnight the carbon was washed free from excess acid (as tested with methyl red solution) in a buchner funnel, dried and sieved. The graded carbon between 20 and 60 mesh was selected for the present work.

**Efficiency of the Carbon as Sulphonic Acid Cation-Exchanger.**—20 g. of the material was supported over a layer of glass wool in a glass-percolating column (1" dia. and 12" ht.). 10% sodium chloride solution was percolated through the carbon bed till the effluent was free from acid. It was then washed free from chloride ions (as tested with silver nitrate solution). 0.1% calcium chloride solution was allowed to percolate through the bed at the rate of 1.5 l./hr. and 250 ml. lots of the effluent were collected successively and analysed for calcium by titration with EDTA using ammonium purpurate as indicator.<sup>8</sup>

TABLE I

Efficiency of the sulphonated groundnut shell carbon in removing calcium from 0.1% calcium chloride solution

Ht. of carbon column = 5.0" Rate of filtration 1.5 l./hr.

Lot No.	Amount of Calcium			
	1st Cycle		2nd Cycle	
	mg. in 250 c.c.		mg. in 250 c.c.	
	in the effluent	taken up by the carbon	in the effluent	taken up by the carbon
(1)	(2)	(3)	(4)	(5)
1	Nil	124.0	0.1	93.9
2	0.1	123.9	0.2	93.8
3	1.5	122.5	0.2	93.8
4	42.0	82.0	2.6	91.4
5	99.0	25.0	26.4	67.6
6	117.0	7.0	64.8	29.2
7	117.0	7.0	84.0	10.0
8	120.0	4.0	90.0	4.0
9	..	..	91.2	2.8
Blank	124.0	..	94.0	..
Total calcium taken up	..	495.4	..	486.5

20 g. of the sulphonated carbon removed about 490 mg. of calcium, i.e., 1 lb. of carbon removed about 28 g. of calcium in terms of calcium carbonate. When the calcium removal was negligible, the carbon bed may be regenerated by percolation with 10% sodium chloride solution.

**Efficiency of the Carbon in Defluoridation of Water.**—One per cent. sodium carbonate solution was percolated through the carbon bed weighing 20 g. and prepared as before till the effluent was alkaline to phenolphthalein. It was then washed free from alkali and treated successively two or three times with 100 ml. lots of 1% alum solution rejecting the effluents. The bed was then left in contact with another 100 ml. portion of the alum solution for 24 hours. The bed was washed free of aluminium ions as tested with hæmatoxylin solution. Tap-water containing about 2.5 p.p.m. of fluorides was percolated through the carbon bed at the rate of 1.2 l./hr. One litre lots of the effluent were collected successively and analysed for fluorine content by Scott-Sanchis' method<sup>9</sup> (Table II). When the fluorine concentration reached the toxic level, the bed was regenerated with sodium carbonate and alum solution as before.

TABLE II

Efficiency of the alum-treated sulphonated  
groundnut shell carbon in removing  
fluorine from tap-water containing  
sodium fluoride

Ht. of the carbon coloumn = 5"		Weight = 20 gm.			
Lot No.	Quantity of fluorine in the effluent (in p.p.m.)				
	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	
(1)	(2)	(3)	(4)	(5)	
1	0.1	0.1	0.2	0.2	
2	0.1	0.2	0.2	0.3	
3	0.3	0.4	0.3	0.3	
4	0.5	0.5	0.5	0.5	
5	0.6	0.7	0.6	0.6	
6	0.8	0.9	0.8	0.9	
7	0.9	0.5	1.0	1.0	
8	1.0	0.6	1.2	1.2	
Blank	2.6	2.5	2.6	2.5	

Volume of water treated to non-toxic levels of fluorine (in litres):				
8	8	7	7	

Twenty grams of the carbon could treat about 7-8 litres of water, i.e., 1 lb. of carbon could treat about 35-40 gallons of water (1 cu.ft. of the material could treat about 782 gallons of water).

The method described appears simple, economical and easily adoptable to rural areas. The capacity of carbon in terms of gallonage of water treated is high. The fact that the technique is as simple as that of ordinary water softening makes the method attractive.

Department of Water D. SEETHAPATHI RAO.

Analysis,  
Institute of Preventive Medicine,  
Hyderabad, October 25, 1963.

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## A DIRECT METHOD FOR ESTIMATION OF STREPTOMYCIN IN FERMENTOR BROTH SAMPLES

A NUMBER of methods are reported in literature for the determination of Streptomycin in culture fluids of which the maltol method is widely used.<sup>1-5,7</sup> For the routine process control analysis a quick and simple method has now been worked out for a direct determination of streptomycin in the fermentor broth samples.

The removal of proteinaceous matter which interferes in the determination was considered a prerequisite in this direct determination. Among the several deproteinising agents, phosphotungstic acid and phosphomolybdic acid could not be used as they cause precipitation of streptomycin also. Trichloroacetic acid on the other hand was found to give a protein-free filtrate in which maltol colour could be determined.

In a series of determinations it was noticed that final fermentor samples which contained nil or negligible dextrose gave results agreeing very closely with the values obtained by standard ion-exchange method. However the values obtained for fermentor samples of early age varied widely from the standard values. This was considered to be due to the interference of dextrose and reducing sugars in the broth, which on heating with alkali are known to give enolic products. The extent of such interference was then investigated by running maltol assay with standard dextrose solutions at varying concentrations from 0.1 to 0.375%, corresponding to the normal dextrose concentrations in diluted broth fluids used in the assay, and by adding known amounts of dextrose in the concentration ranges 0.1-0.30% to standard streptomycin solution. The dextrose interference is additive and constant in the ranges reported (Graph 1).

The values in the direct determination agreed with the values by standard ion-exchange method after correcting for dextrose (Table I).

TABLE I

Sl. No.	Dextrose %	Streptomycin by direct method (after correction for residual dextrose) $\mu$ /ml.	Streptomycin by ion-exchange $\mu$ /ml.
1	3.16	4500	4500
2	Nil	8015	7950
3	1.0	7800	7900
4	2.67	2810	2850
5	3.1	4250	4350
6	Nil	6300	6322
7	2.82	2350	2300
8	3.34	3820	3900
9	Nil	7800	7900
10	3.05	5450	5550

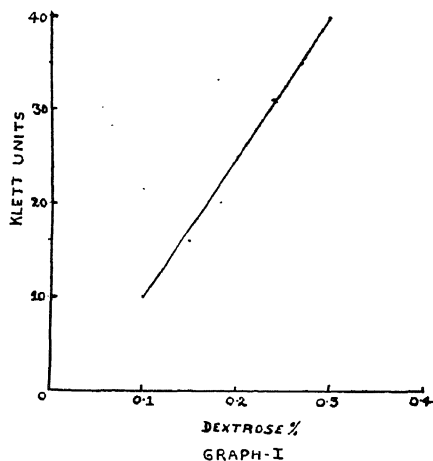
The procedure for estimation of Streptomycin culture fluids is as follows:

The broth sample (96 ml.) is acidified with trichloroacetic acid solution (1 gm./ml.) (4 ml.) (pH 2) and filtered. The filtrate is centrifuged and the clear solution is taken for assay. The centrifuged broth is diluted (1:10).

To 5 ml. of the broth sample is added sodium hydroxide (2 ml. 2N) immediately followed by 4 ml. of ferric reagent (2% ferric ammonium sulphate in 1.3N Sulphuric acid) (Blank).

5 ml. of the broth sample and 2 ml. of sodium hydroxide are heated on a boiling water-bath for 3 minutes, the solution cooled to room temperature and ferric reagent (4 ml.) added (Test). The colour is determined against blank set to zero on the Klett Summerson Colorimeter (Filter 54). A standard Streptomycin solution (500  $\mu$ /ml.) is also run simultaneously.

From the dextrose concentration of the test sample correction factor is determined from Graph I. From the corrected Klett reading and the reading for standard Streptomycin, the Streptomycin content in the test sample is calculated.



The validity of the modified method was checked by adding known amounts of Streptomycin to the culture filtrates and determining Streptomycin content before and after addition.

TABLE II  
Increment analysis

Sl. No.	Calculated value Streptomycin $\mu$ /ml.	Streptomycin by direct method $\mu$ /ml.	Deviation %
1	3450	3350	-2.9
2	4820	4720	-2.1
3	5500	5600	+1.8
4	4500	4350	-1.9
5	6250	6300	+0.8

In the above determination the following points require special mention. The blanks have to be run with the corresponding fermentor samples to avoid fluctuations that may arise due to differences in the colour of the broth. The heating for maltol development is done for exactly 3 minutes as longer heating causes lower values, due to further decomposition of maltol.<sup>6</sup> The final samples of fermentor broth require no dextrose correction as at levels lower than 0.5%, the interference is negligible. This simple method eliminates the more time-consuming process of ion-exchange absorption and subsequent elution and can be completed in comparatively shorter time. In an analysis of over 100 fermentor samples of various ages and of different potencies in the range 2,000  $\mu$ /ml. to 9,000  $\mu$ /ml. the mean deviation between the values by this modified method and the standard ion-exchange method, was found to be  $\pm 1.69\%$ .

Plant Laboratory, K. M. DESAI  
Streptomycin Plant, N. NARASIMHACHARI  
Hindustan Antibiotics Ltd., G. RAMANA RAO.  
Pimpri, November 14, 1963.

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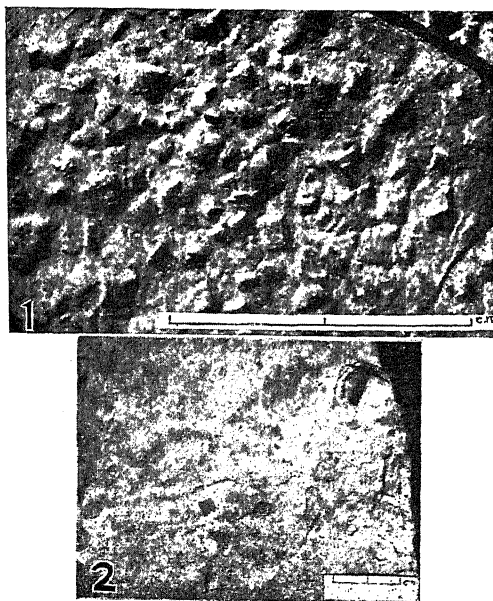
#### SALT-PSEUDOMORPHS IN SHALES OF JODHPUR FORMATION

In the course of mapping the red-beds around Sonia (26° 44' : 73° 44'), Bilara tehsil, Rajasthan, during early 1959, the senior author and Sri. V. S. Depura<sup>1</sup> discovered a twenty-five-foot thick purple coloured shale bed with salt-pseudomorphs in the basal part. This bed is interbedded with the red sandstone, chert and purple clays of the Jodhpur Formation\* formerly called the 'Vindhyaans'. The bed is exposed in the isolated hills lying north of spot height 1,276 feet in a stretch of 12 miles. It has now been traced on the Sankla-ki-dhani (26° 34' : 73° 37') scarp for nearly 16 miles in this scarp with the salt-pseudomorphs at the base. It may now be classified as a "member" within the Jodhpur Formation, as shown in Table I,

TABLE I

<i>Bilara Formation</i> (125 feet) Older Palaeozoic (?)	Light grey to dark grey limestones and cherty limestones
Unconformity	
	Pink to dark brown, ferruginous sandstone and grit—100 feet.
	Red sandstones, purple clays with variegated argillaceous sandstones topped by bands of white and pink chert—100 feet.
<i>Jodhpur Formation</i> (350 feet) Older Palaeozoic (?)	Purple shales with salt-pseudo- morphs in the basal five-foot sequence, and interbedded thin sandstones—25 feet.
	Red and pink, current-bedded, sometimes oolitic sandstones, grits and conglomerates—125 feet.
Unconformity	
Basement	Pink and greyish-white granite

The salt-pseudomorphs occur as cubic casts on the top of many thin laminæ of the shales. Sometimes only three edges of the cube are preserved giving rise to a prominent three-rayed form. The maximum development of the salt-pseudomorphs, varying in size from one to two millimeter square, is observed at the base of the salt-pseudomorph horizon (Fig. 1). In the upper portion of the horizon only few but well-developed casts (as big as 1 to 1½ cm. square) are seen (Fig. 2).



FIGS. 1-2

Sir Cyril Fox correlated the red-beds of Pokaran (belonging to Jodhpur Formation) with the Purple Sandstone of the Salt Range on the

lithological analogy.<sup>2</sup> The discovery of salt-pseudomorph shales associated with purple sandstones in western Rajasthan is another evidence for such a correlation. Similar salt-pseudomorphs have also been reported from eastern Rajasthan.<sup>3</sup>

O.N.G. Commission,  
Dehra Dun,  
October 22, 1963.

B. P. SHRIVASTAVA.  
S. SRINIVASAN.

\* The rock stratigraphic name given to the red-beds of western Rajasthan (earlier called 'Vindhyans') by ONGC geologists.

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#### TRANSGRESSING MARINE BEACH IN CUDDAPAH BASIN, SOUTH OF KARNOL, A.P.

THE first detailed account of the geology of Cuddapah basin was given by W. King<sup>1</sup> (1872) in his Memoir on Cuddapah basin. Later on Dr. M. S. Krishnan<sup>2</sup> has given a description of the geology of Veldurthi area, while describing the iron ores of Ramalla Kota. The Sedimentary Petrographic studies on the Gulcheru Conglomerates which form the basal beds of the Lower Cuddapah basin have been carried out to study the nature of their sedimentation in the Cuddapah Basin. About 250 square miles south of Kurnool Town in GTS Topo Sheet Nos. 57 E/14 and I/2 were mapped on 1" = 1 mile scale. The Gulcheru Conglomerate bed runs roughly N-S with an average thickness of about 15 ft. At ten locations along the outcrop, the intercepts of the individual pebbles in the Conglomerate were measured and the size and flatness ratio were calculated and given in Table I.

The pebbles in the Conglomerate are mostly of Quartz and so the Conglomerate may be called, according to Pettijohn,<sup>3</sup> Oligomictic. The maximum pebble size is 5·40 at location I and the minimum 1·80 at location IV. It can be seen from Table I that there is a fairly good correlation between thickness of the Conglomerate bed and the mean size of the pebbles, which increases with the thickness of the bed. The pebbles have a sorting coefficient



TABLE I  
Parameters of the Gulcheru Conglomerate

Loca- tion	Thick- ness of bed in feet	Average size in cms.	Sorting Co- efficient	Flatness ratio	
				50 Percentile	85 Percentile
I.	30	5.40	1.48	2.20	3.0
II.	15	2.45	1.27	3.86	4.9
III.	20	4.50	1.63	2.99	4.5
IV.	8	1.80	1.28	3.78	5.6
V.	10	1.90	1.35	2.49	3.6
VI.	18	2.85	1.49	3.27	4.2
VII.	15	2.50	1.80	3.23	4.4
VIII.	20	3.55	1.40	2.87	3.8
IX.	10	2.20	1.35	2.61	3.7
X.	20	3.45	1.32	3.13	4.1
Average	16.6	3.06	1.39	3.04	4.18

( $S_0$ ) below 2.5 and according to Trask<sup>4</sup> well-sorted marine sediments have values of  $S_0$  less than 2.5. According to Pettijohn<sup>5</sup> the marine pebbles are flat having a flatness ratio over 2.3. It can be seen that in all the ten locations the 85 percentile is more than 2.3. The flatness ratio is minimum (3.0) at location I where the bed has maximum thickness, whereas it is maximum (5.6) at location IV where the thickness of the bed is minimum. These characteristics definitely indicate that the pebbles must have been formed on a transgressing Marine beach.

The author is thankful to Dr. S. Balakrishnan, Head of Geology Department, Osmania University, for his encouragement and valuable suggestions.

Geology Department, B. E. VIJAYAM.  
Osmania University,  
Hyderabad-7, November 29, 1963.

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# ON THE OCCURRENCE OF *GLOBOTRUNCANA* IN ARIYALUR STAGE OF TRICHINOPOLY CRETACEOUS, SOUTH INDIA\*

THE note records for the first time the occurrence of *Globotruncana lapparenti tricarinata* (Quereau) from the Ariyalur stage of the Cretaceous formations of Trichinopoly, Madras. Foraminifera and Ostracoda have been reported

from the *Gryphaea* beds of Maestrichtian age by earlier workers of which a review is given by Rama Rao.<sup>1</sup> The occurrence of *Globotruncana* sp. from these beds has also been noted by Sastry, Sastri and Tripathi.<sup>2</sup> The present record is from beds which occupy stratigraphically a lower horizon than the *Orbitoid*-bearing, Maestrichtian beds exposed east of Ariyalur. About 130 metres thick unfossiliferous sands and clays with intercalations of thin, poorly fossiliferous beds (no foraminifera have been found in these beds) separate the *Orbitoid*-bearing beds from the *Globotruncana lapparenti tricarinata*-bearing beds. Typical foraminiferal species of Maestrichtian age like *Lepidorbitoides inornata*, *L. blanfordi*, *Orbitocyclina ariyalurensis* and *Siderolites calcitropoides* found in the former are absent in the underlying and *Globotruncana lapparenti tricarinata* beds.

The samples were collected by the authors during 1963, north of Ariyalur, in a *nala* section 0.5 km. east of Sadaiyakkannapatti (11° 10' 79" 03' 30"). The outcrop consists of about five metres thick fossiliferous, cream-coloured, gritty sandstone with subordinate buff clays. The samples have yielded the following Foraminifera and Ostracoda:

## Foraminifera

- Anomalina* sp.
- Cibicides* sp.
- Fronicularia goldfusi* Reuss.
- Globotruncana lapparenti tricarinata* (Quereau)
- Globotruncana* cf. *lapparenti lapparenti* Brotzen
- Globotruncana* sp. A. (double-keeled)
- Globotruncana* sp. B. (single-keeled)
- Gumbelina globulosa* (Ehrenberg)
- Guttulina trigonula* (Reuss)
- Gyroldina* sp.
- Marginulina* sp.
- Nodosaria affinis* Reuss
- Nodosaria* sp.
- Quinqueloculina* sp.
- Robulus* sp.
- Spiroplectammina* sp.
- Textularia* sp.
- Vaginulina* sp. A
- Vaginulina* sp. B

## Ostracoda

- Bairdia* sp.
- Bairdopillata* sp.

The occurrence of *Globotruncana lapparenti tricarinata* and *G. cf. lapparenti lapparenti* in these beds and their stratigraphically a lower

position from that of the *Orbitoid*-bearing beds, indicate a Campanian age to them. A detailed account will be published elsewhere.

Central Palaeontological M. V. A. SASTRY.

Laboratories, V. D. MAMGAIN.

Geol. Surv. India, B. R. JAGANNATHA RAO.  
Calcutta, February 19, 1964.

\*Published with the kind permission of the Director-General, Geological Survey of India.

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### A NEW RECORD OF ANGIOSPERMIC LEAF IMPRESSIONS FROM THE GARO HILLS, ASSAM

LAST YEAR Mr. S. K. Borooah, Director of Geology and Mining, Assam, gave Dr. M. N. Bose of our Institute a small collection of leaf impressions made by Shri R. Quddus from Nangalbibra (25° 27' N.; 90° 42' E.) in the Garo Hills district of Assam. They were collected from the Tura sandstone of the West Darangiri coalfield in Garo Hills, quite close to the proposed site of thermal plant at Nangalbibra. Dr. Bose has very kindly passed on the material to me for examination.

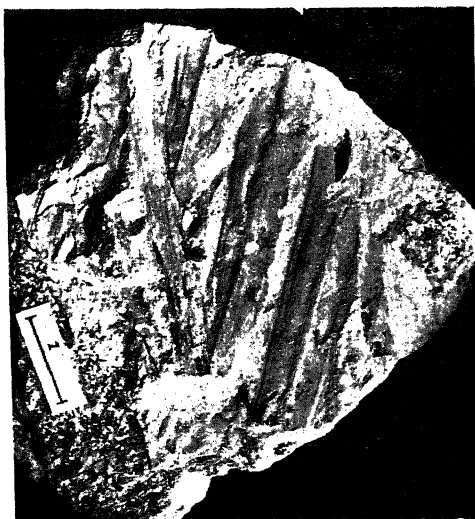


FIG. 1

Unfortunately the preservation of the leaf impressions is not very good and almost all of

them are incomplete. However, it is possible to recognize amongst them the basal parts of the leaves of *Neolitsea sahnii* and leaflets of *Bombacites orientalis* which I had described earlier (Lakhanpal, 1954) from Damalgiri (25° 32' N.; 90° 7' E.), another locality in the Garo Hills, a few miles north-west of Nangalbibra. Besides, there are two leaflets possibly of a legume and an incomplete leaf impression of a *Poenix*-like palm (Fig. 1) which could be referred to the genus *Phoenicites*.

This collection as well as the specimens already described from Damalgiri very strongly suggest that a thorough search in the Garo Hills may reveal quite a sizeable early Tertiary flora which would throw considerable light on the phytogeography and palaeoecology of this region.

Birbal Sahni Institute of R. N. LAKHANPAL.  
Palaeobotany,  
Lucknow, March 19, 1964.

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### EFFECT OF INSULIN ON THE AMINO NITROGEN CONTENT OF FREE AMINO-ACIDS IN THE BLOOD AND FOOT OF *MERETRIX CASTA* (CHEMNITZ)

In a previous paper, one of us<sup>1</sup> communicated the results of experiments relating to the effect of insulin on the carbohydrate metabolism of *Meretrix casta* (Chemnitz).

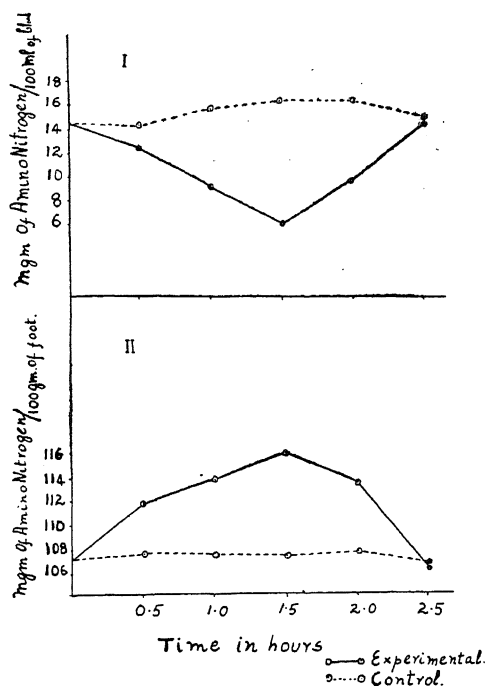
The present account deals with the effect of insulin injection on the amino nitrogen content of the free amino-acids in the blood and foot of *Meretrix casta* (Chemnitz). Observations show that, following the injection of insulin, the amino nitrogen of the free amino-acids of blood shows a fall and this is accompanied by a corresponding rise in that of the free amino-acids of foot.

Standard doses of 1 unit of insulin/5 gm. body weight were injected. Controls were maintained for each experiment. Distilled water equal in volume to that of insulin used in the experiments, was injected into the control specimens. After insulin treatment a known volume of blood and a known weight of foot were taken at successive intervals of 0.5, 1.0, 1.5, 2.0 and 2.5 hours. Amino nitrogen estimations were carried out as described by Hawk *et al.*<sup>2</sup> The results are given in Table I and plotted in Figs. 1 and 2.

TABLE I

Amino nitrogen after insulin injection in the free amino-acids of blood and foot of  
*Meretrix casta* (Chemnitz)

Tissue	Time in hours	0	0.5	1.0	1.5	2.0	2.5
Blood mgm./100 ml. ..	Control	14.50	14.23	15.94	16.37	16.25	14.65
	Experimental	..	12.52	9.22	6.07	9.68	14.17
Foot mgm./100 gm. (wet weight)	Control	107.12	107.85	107.51	107.56	107.97	106.58
	Experimental	..	111.88	113.90	116.00	113.58	106.10



FIGS. 1-2. Fig. 1. Effect of insulin on the amino nitrogen content of free amino-acids in the blood of *Meretrix casta*. Fig. 2. Effect of insulin on the amino nitrogen content of free amino-acids in the foot of *Meretrix casta*.

Figure 1 shows the effect of insulin on the amino nitrogen of the free amino-acids of blood and Fig. 2 shows that of the foot. The amino nitrogen of the free amino-acids of the blood shows a decline which lasts for 1.5 hours. The declining phase is followed by a recovery phase. At the end of 2.5 hours, the amino nitrogen content of the free amino-acids of blood recovers almost to the normal value. Regarding the free amino-acids of foot, the amino nitrogen content increases after injection. Till 1.5 hours, there is an increase and then a fall towards normal value. Figures 1-2 show the striking parallel

between the fall and recovery of the amino nitrogen of the free amino-acids of the blood on the one hand, and the increase and fall of that of the foot free amino-acids on the other.

What is known so far regarding the effect of insulin on free amino-acid in tissues is from experiments on dogs and particularly from experiments using the rat diaphragm. Lot-speich<sup>3</sup> found that the amino-acids which leave the plasma in insulin-treated dogs do so in just the proportion in which they occur in protein of the muscle. It has been conclusively shown that insulin could promote amino-acid incorporation into proteins. But all the work so far has been done on warm-blooded animals and none on invertebrates.

One of the authors<sup>1</sup> in a previous paper suggested that the foot of the clam, *Meretrix*, might be a stable store in carbohydrate metabolism. The present account would show that the foot has an important role in metabolism. The rise in amino nitrogen of the free amino-acids in the foot would indicate that the potential of the metabolic pool in the foot increases when amino nitrogen in blood decreases. Whether the increase in amino nitrogen would indicate increased incorporation of the amino-acids into peptides of the foot is not known. Further work is in progress.

Our thanks are due to Prof. R. V. Seshaiya, Director, for suggesting the problem and for guidance and instruction.

U.G.C. Centre for S. KASINATHAN.  
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Porto Novo, December 19, 1963.

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ON THE DEVELOPMENT OF  
FREE-LIVING STAGES OF  
*AMIDOSTOMUM SKRJABINI*—  
A PATHOGENIC NEMATODE IN  
DOMESTIC DUCK

IN *Amidostomum* Railliet and Henry, 1909, the type species *A. anseris* (Zeder, 1800) is one of the important pathogenic nematodes parasitic in domestic geese and to some extent in domestic duck. The Indian domestic duck, *Anas platyrhynchos domesticus*, has recently been reported to harbour an infection with *A. skrjabini* Boulenger, 1926, known from various species of ducks (Dubey, 1963<sup>1</sup>). Like other species in this genus, its adult stage lives inside the horny lining of the gizzard. It was studied for its development of eggs, laid by females and present in cloacal samples, through the free-living stages to the infective form. Female worms, after extraction, were left for oviposition in small petri dish with small amount of water which was changed twice a day. The larval development, followed in laboratory culture through its first, second and infective or preparasitic stages, was recorded. For study, the larvæ were transferred to a drop of water on a slide covered with cover-glass and killed with gentle heat. Living larvæ were also stained with Janus green and Neutral red. Camera lucida drawings were made of the developmental stages in eggs and larvæ.

Ova, measuring 73–81  $\mu$  in length and 40–48  $\mu$  in width, ovoid in shape, with thin transparent shell, 8-celled at the time of laying but 16 or 32-celled when present in faeces, assumed multicelled form as an irregular mass (gastrula stage) in 4–5 hours, a tadpole form in 10–12 hours and reached the fully embryonated stage in 15–17 hours (Fig. 1). Hatching started after 20 hours. Larva wriggled out through a

small opening formed at the weaker spot on the shell.

Freshly hatched larva long, filiform, with a more tapering posterior end, measuring 529–540  $\mu$  in length and 13–15  $\mu$  in width. Cuticle unstriated. Mouth, with a circumoral prominence, leading into a small cylindrical buccal capsule continuing into the rhabditiform oesophagus of 120–127  $\mu$  in length; intestine full of dark food granules. Tail, 77–81  $\mu$  in length, showed a minute swelling behind its tip. Circum-oesophageal nerve-ring, situated at 90–100  $\mu$  from the anterior end, with a group of nuclei and cells representing the ganglia. Excretory pore 40  $\mu$  distance behind the nerve-ring. Genital primordium elongated in form and at 280–296  $\mu$  distance from the anterior end (Fig. 2, a).

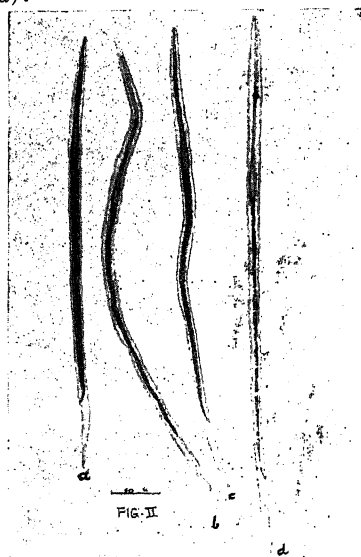


FIG. 2

First ecdysis occurred on the third day after laying of the eggs. The second-stage larva, still inside its old cuticle (Fig. 2, b), had a shape similar to that of the first stage. On shedding of the old cuticle, which invariably exhibited an inflation at its tip, the larva became actively motile and measured 552–585  $\mu$  in length and 13–15  $\mu$  in width with its oesophagus 150–200  $\mu$  long. The genital primordium, shifted comparatively posteriorly, lay at 307–337  $\mu$  distance from anterior end. The tail, without showing any increase in size, exhibited a prominent constriction behind its tip (Fig. 2, c).

The second ecdysis was reached, after 4th day of the egg-laying but in some forms it took five days. The larvæ showed characteristically two

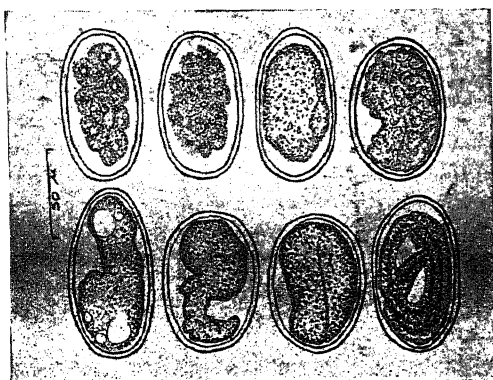


FIG. 1

cuticles, older cuticular sheath being tightly fitted all round. Its separation, however, was apparent on application of gentle heat to the slide. The infective or preparasitic stage measured 600-648  $\mu$  in length and 12-13  $\mu$  in breadth. Oesophagus, thin and long, without a bulb, measured 207-222  $\mu$  with the nerve-ring lying at 127-148  $\mu$  distance from the anterior end. The genital rudiment had further shifted posteriorly so as to lie 351-377  $\mu$  distance from the anterior end. Tail characters were similar to those in the second stage (Fig. 2, d) but with a slight inflation at the posterior end of the sheath. The infective stage, in the laboratory culture, was found to live for as long as thirteen days.

The data on the rearing studies, presented herein, show a few salient variations from similar observations recorded in respect of *A. anseris*. As cited by Lapage<sup>3</sup> (1962), Kobulej<sup>2</sup> (1956) who had studied embryonic and post-embryonic development in that species had stated that the entire development to the infective larval stage occurred inside the egg and that the third larval stage was enclosed by the two skins, i.e., the first and second ecdyses took place within the egg shell and the infective larvæ survived from three to four weeks (Kobulej, 1956). In our material, the first ecdysis occurred outside. Accordingly, the infective stage had only one sheath, that of the second moulting, and in the laboratory survived for thirteen days, i.e., nearly two weeks.

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November 21, 1963.

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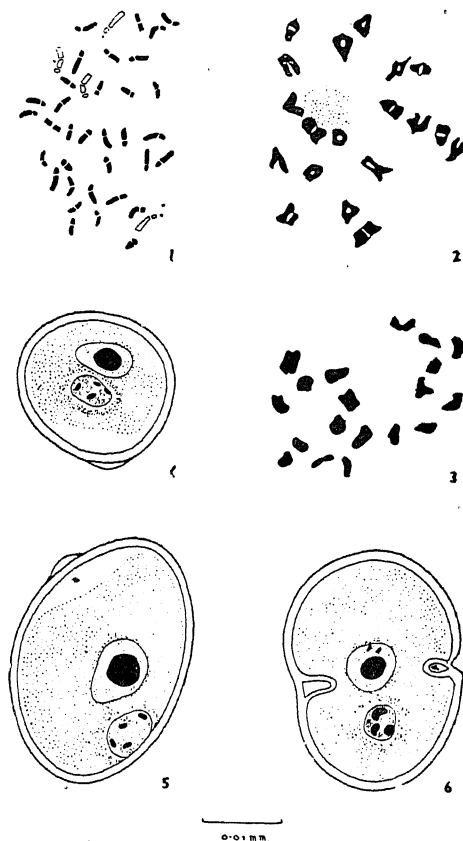
#### CYTOLOGY OF *FLAGELLARIA INDICA* LINN.

FLAGELLARIACEÆ are a small family comprising of about eight species under three genera, namely, *Joinvillea* Gaud., *Flagellaria* Linn. and *Hanguana* Blume (= *Susum* Blume), the last one being monotypic (Backer, 1951). They are confined to the tropics of the Old World and *Flagellaria indica* is the only species reported from India (Hooker et al., 1892). The members of this family have escaped the attention of the cytologists, apparently due to the paucity of material. Consequently, the present paper

is the first contribution to the cytology of the family.

Observations on somatic chromosomes were made from root-tip cells for which suckers from plants growing wild in Changail, Howrah District (W. Bengal), were grown in pots. Root tips were pretreated for 2-3 hours at 10° C. in saturated solution of paradichlorobenzene, fixed in acetic alcohol (1:3) to which was added a trace of ferric acetate and stored in a refrigerator for 3-4 days. They were then heated in a mixture of 2% aceto-orcein and N HCl (9:1) and kept in that mixture for about an hour. Squashing was done in 1% aceto-orcein. For meiotic studies flower-buds from plants growing in the field were fixed in propionic alcohol (1:3) and the microsporocytes were smeared in propiono-carmin. Voucher specimens (Bennet, 272) have been deposited in the Central National Herbarium, Calcutta.

The diploid chromosome number is 38 (Fig. 1). The chromosomes are medium to small in size.



FIGS. 1-6. Fig. 1. Somatic chromosomes ( $2n=38$ ). Fig. 2. Diakinesis ( $n=19$ ). Fig. 3. Metaphase I ( $n=19$ ). Fig. 4. Normal pollen grain. Fig. 5. 'Giant' pollen grain. Fig. 6. Giant pollen grain constricted in the middle.

Depending on their morphology, they can broadly be classified as follows: (1) A pair of medium-sized chromosomes, each having a submedian constriction and a satellite at the end of the short arm. (2) A pair of medium-sized chromosomes, each having two constrictions, primary and secondary, one nearly median and the other nearly submedian in position. (3) A pair of medium-sized chromosomes with submedian constrictions. (4) Thirteen pairs of comparatively small chromosomes with nearly submedian constrictions. (5) Three pairs of comparatively small chromosomes with median constrictions.

During diakinesis and Metaphase I 19 bivalents are noticed (Figs. 2 and 3). Anaphase I is normal and cytokinesis does not follow the first division. Distribution of chromosomes at Anaphase II is also regular. The division of the microspore mother cells is of the simultaneous type. This type of division of the mother cells, although not quite prevalent in the monocotyledons, has been reported in Iridaceae, Taccaceae, Juncaceae and Dioscoreaceae and in several genera of Liliaceae, Palmæ and Orchidaceae (see Maheshwari, 1950, p. 45). Occasionally, after the completion of the second division, two of the nuclei fuse together resulting in triads. The large microspores thus formed give rise to 'giant' pollen grains. The percentage of giant pollen grains produced is 0.7 and they measure  $30.7\mu$  by  $25.9\mu$  (Fig. 5), while in the normal ones the diameter is  $20.1\mu$  (Fig. 4). Rarely the giant pollen grains are constricted in the middle (Fig. 6). The fertility of the pollen grains, as ascertained by their stainability with acetocarmine, is 93.6%. They are 1-ulcerate and are shed in 2-celled condition.

It is of interest to note that according to Erdtman (1952, p. 180) *Hanguana malayana* differs from *Flagellaria* and *Joinvillea* both in pollen morphology and epidermal structure and should probably not be referred to Flagellariaceae. A comparative study of the cytology and embryology of *Hanguana malayana* with other members of the family is likely to throw more light on this problem.

Grateful thanks are due to Rev. Father H. Santapau and Dr. S. K. Mukerjee for their interest in this investigation, and to Shri S. S. R. Bennet for his help in the collection of material.

Botanical Survey of India, B. V. SHETTY.\*  
Calcutta, January 22, 1964. K. SUBRAMANYAM.

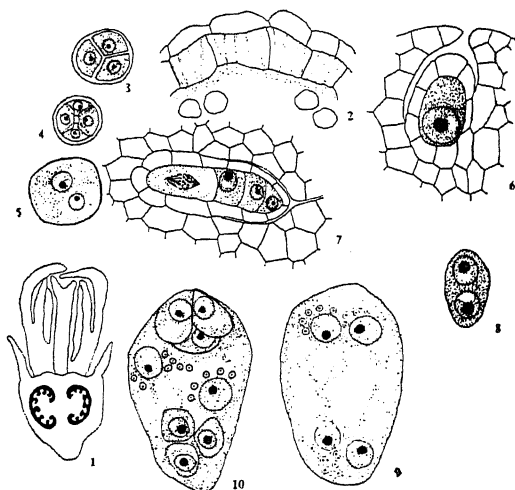
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### A CONTRIBUTION TO THE EMBRYOLOGY OF *RONDELETIA AMOENA* HEMSL.

EARLIER embryological studies in Rubiaceae include contributions made by Schleiden (1837), Lloyd (1902), Schnarf (1931), Fagerland (1936 a, 1936 b, 1937), Raghavan and Rangaswamy (1941), Raghavan and Srinivasan (1941), Raman (1954), Venkateswaralu and Rajeswara Rao (1954), Farooq (1958, 1960), Ganapathy (1956 a, b), Shivaramiah and Ganapathy (1961) and Gopinath and Chennaveeraiah (1961).

The genus *Rondeletia* Linn. belongs to the subfamily Cinchonoideae, tribe Rondeletieae (Willis, 1960) because of its multiovulate condition. This genus remains embryologically uninvestigated so far. Our material was collected in the Indian Botanical Gardens, Ootacamund.

The inflorescence is cymose with pentamerous, bisexual, actinomorphic, epigynous flowers. The ovary is bicarpellary, bilocular, with numerous, hemianatropous ovules on an axile placenta (Fig. 1).



FIGS. 1-10. Fig. 1. L.s. of young flower-bud,  $\times 60$ . Fig. 2. Portion of anther wall showing fibrillar endothecium,  $\times 1,200$ . Figs. 3-4. Tetrahedral and decussate arrangement of microspores,  $\times 1,500$ . Fig. 5. Two-celled pollen grain,  $\times 1,500$ . Fig. 6. L.s. of ovule showing hypodermal archesporial cell,  $\times 1,200$ . Fig. 7. Linear tetrad of megaspores,  $\times 1,200$ . Figs. 8-9. Two and four nucleate embryo-sac,  $\times 1,500$ . Fig. 10. Eight-nucleate embryo-sac,  $\times 1,500$ .

\* Present address: Botanical Survey of India, 63-Rajpur Road, Dehra Dun, U.P.

The anther is four-lobed; in each of these lobes is a group of microspore mother cells surrounded by the tapetum, middle layer, endothecium and epidermis. The tapetal cells are glandular and uninucleate throughout. At maturity, endothecium exhibits usual fibrillar thickenings (Fig. 2). The microspores are tetrahedral but occasionally decussate in arrangement (Figs. 3 and 4). Pollen grains are triporate, having a smooth exine and a thin intine. The mature pollen grains are two-celled (Fig. 5).

The ovules are tenuinucellate and unitegmatic. A single hypodermal archesporial cell directly functions as the megaspore mother cell (Fig. 6). At this stage of development, the integument shows distinct growth over the nucellus. The nucellus consists of 5 cells as in *Knoxia corymbosa* Willd. and conforms to the 'primitive Phyllis type' (Fagerlind, 1937). The megaspore mother cell by meiotic divisions gives rise to a linear tetrad of megaspores (Fig. 7). The occurrence of linear tetrad of megaspores appears to be usual in the majority of the members of the family, although T-shaped tetrads occur in *Oldenlandia corymbosa* Linn. (Farooq, 1958). The upper three megaspores degenerate, while the nucleus of the functioning megaspore by three successive divisions develops into an eight-nucleate embryo-sac of the Polygonum type (Figs. 8-10). The antipodals are three-celled. It is interesting to note that the embryo-sac becomes filled with starch grains at its chalazal end even at the four-nucleate stage. Subsequently, starch grains become scanty at the antipodals and show a gradual migration and concentration around the egg apparatus and polars. The synergids are neither hooked nor beaked.

Our thanks are due to Prof. S. Shamanna for guidance and to Rev. Fr. E. D'Souza, S.J., Principal, St. Joseph's College, Bangalore, for encouragement.

Dept. of Botany, G. SHIVARAMIAH.  
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### PIGMENT CHARACTERISTICS OF ANTIBIOTIC-RESISTANT STRAINS OF A BLUE-GREEN ALGA

In a previous paper<sup>1</sup> the effect of streptomycin on the growth and pigmentation of a unicellular blue-green alga, generally known as *Anacystis nidulans* (Myers' strain, in pure bacteria-free culture) and the production of strains of this alga which are resistant to high concentrations of streptomycin and penicillin, was described. The object of this paper is to record the pigment characteristics of these strains after their repeated subculture in the presence of the antibiotic and to compare them with those of the untreated wild strain.

The strains used were those resistant to 20 mg. streptomycin sulphate/100 ml. and 2.0 mg. benzylpenicillin (sodium salt)/100 ml. Both had been subcultured in the respective medium at least ten times. The general techniques of producing and maintaining these strains and details of the culture methods have been previously described.<sup>1,2</sup>

In preparation for experiments the cells were harvested by centrifuging the cultures at 2,500 r.p.m. for 30 minutes, washed once in water and re-centrifuged. Pigments of one aliquot were extracted by suspending the cells twice in 80% aqueous acetone, centrifuging, pooling the supernates and making them up to 25 ml. Pigments of another aliquot were examined in aqueous extracts obtained in the following manner. The cells were suspended in 10 ml. of distilled water, transferred to a strong-walled stainless steel container and broken in a French Press by applying a pressure of 5,000 lb./square inch. The suspension was then centrifuged at about 4,500 r.p.m. for 45 minutes and the supernatant made up to 25 ml. Absorption spectra of the pigment extracts were determined in a

Unicam S.P. 500 Spectrophotometer using 1-cm. cuvettes.

The results obtained are shown in Fig. 1 (acetone extracts) and Fig. 2 (aqueous extracts). In acetone extracts there are two major absorption peaks: (1) at  $430\text{--}35\text{ m}\mu$  in untreated control strain, at  $450\text{ m}\mu$  in streptomycin-resistant strain and at  $430\text{ m}\mu$  in penicillin-resistant strain, and (2) at  $663\text{ m}\mu$  in all the three strains. The first peak is believed to be due to both chlorophyll-*a* and carotenoids and is highest in the untreated strain and lowest in the penicillin-resistant strain. The second peak (at  $663\text{ m}\mu$ ) is due to chlorophyll-*a* and is highest in the penicillin-resistant strain and lowest in the streptomycin-resistant strain. This effect was also reflected in the visible appearance of the cultures: the penicillin-resistant strain looked bright bluish-green in contrast to the streptomycin-resistant strain which was somewhat bleached and had a yellowish-brown tinge.

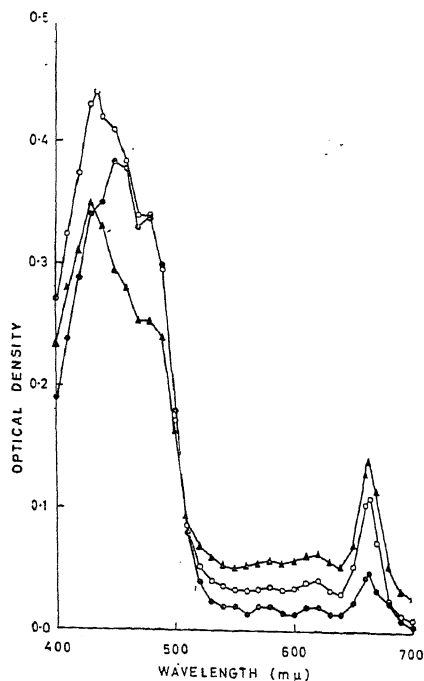


FIG. 1. Absorption spectra of acetone extracts of approximately equal cell lengths (corresponding to  $15 \times 10^8$  cells from untreated control strain) of 7-day old cultures of the antibiotic-resistant strains.

- 20 mg. streptomycin/100 ml.-resistant strain.
- ▲—▲ 2.0 mg. penicillin/100 ml.-resistant strain.
- Untreated control strain.

Three maxima were revealed in the aqueous extracts: (1) at  $440\text{ m}\mu$ ; (2) at  $618\text{--}20\text{ m}\mu$  and (3) at  $675\text{--}77\text{ m}\mu$ . Of these the one at  $618\text{--}20\text{ m}\mu$  is due to phycocyanin absorption and is most pronounced in the penicillin-resistant strain and feeble in the streptomycin-resistant strain.

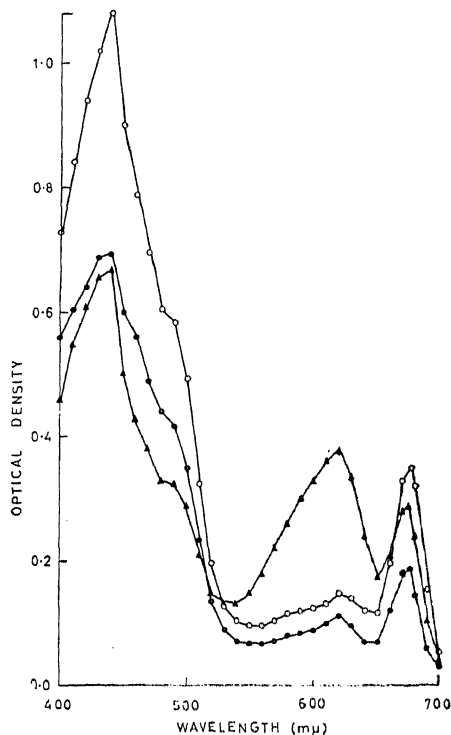


FIG. 2. Absorption spectra of aqueous extracts of approximately equal cell lengths (corresponding to  $45 \times 10^8$  cells from untreated control strain) of 7-day old cultures of the antibiotic-resistant strains. (Points as in Fig. 1.)

This work was carried out in the Department of Botany, Westfield College, University of London, during the tenure of a Commonwealth Scholarship. I am extremely indebted to Professor G. E. Fogg for his kind interest and encouragement.

Department of Botany, H. D. KUMAR.  
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**FUSARIUM ROT OF TAROI [*LUFFA*  
*CYLINDRICA* (LINN.) M. ROEM]**

DISEASED fruits of Taroi [*Luffa cylindrica* (Linn.) M. Roem] were obtained from the local fruit market, during July-October 1960. The disease was characterised by slightly sunken rotted areas (3-4 inches in length). It invariably appeared towards the stalk end, and the lesions were tan to brownish-black in colour. Isolations from the diseased fruit consistently yielded a species of *Fusarium*. This was sent to Commonwealth Mycological Institute, Kew, where it was identified as *Fusarium semitectum*<sup>1</sup> Berk et Rav. No species of *Fusarium* has ever been reported to be associated with any disease of 'Taroi', and therefore, this is the first record from India or elsewhere.

This note includes a description of the disease under natural and controlled environmental conditions, the host range of the organism and its general morphology.

The first symptom of the disease on fruits of 'Taroi' is a light brown to tan lesion occurring at the stalk end (Fig. 1), where the injury is

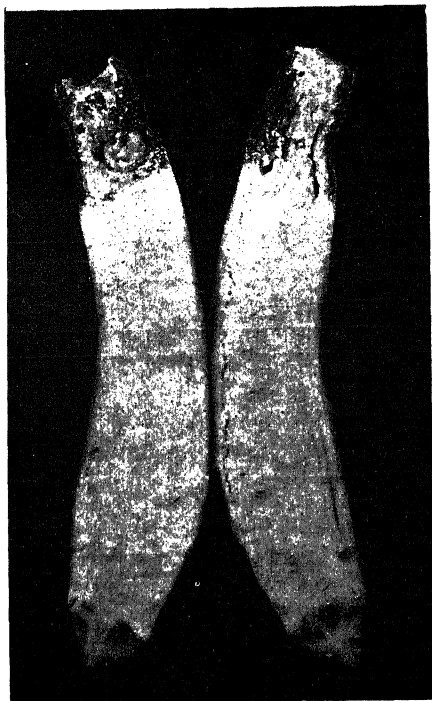


FIG. 1

invariably obvious. This affords a convenient point of entry. Lesions typically radiate from the point of infection at the stalk end. The

invasion of the new tissue often continues, until the entire fruit is discoloured. Tissue fragments from the diseased fruits collected from the local market yielded isolates of *F. semitectum*, which was isolated from 56 out of 68 tissue plantings. The isolates were inoculated into healthy, uninjured, green 'Taroi' fruits which had been previously sterilized. Granger and Horne's<sup>2</sup> method was used for this purpose. The inoculated fruits were kept in moist chambers at a controlled temperature ( $25^{\circ}\text{C} \pm 1$ ) and were observed daily. Controls were simultaneously arranged in every case. Every inoculated fruit showed the characteristic symptoms after 3-5 days, but the controls remained healthy. Tissue isolations were made from each diseased fruit and only *Fusarium semitectum* was recovered.

Two types of bacteria were also obtained from the tissue fragments (a white-pigmented and a yellow-pigmented). Their frequency was much less and they were observed in 15 cases only. Artificial inoculations were made by them also, but none of them were parasitic on "Taroi" fruits. Wherever these bacteria were inoculated into sterilized green "Taroi" fruits in different combinations with *Fusarium semitectum*, they developed the symptoms similar to those induced by the fungus alone. The only difference was that the rotted areas were watery and had dark brown to black colour. It appears that the bacteria caused the watery condition on account of the saprophytic growth on tissues killed by *Fusarium semitectum*.

Extensive cross-inoculations were carried out and it was observed that the organism had a wide range including various members of the family Cucurbitaceæ and some Solanaceæ, viz., *Lagenaria vulgaris*, *Luffa acutanglia*, *Cucumis melo*, *Citrullus vulgaris*, *Citrullus colocynthis*, *Cucurbita pepo*, *Solanum tuberosum* and *Solanum melongena*. The organism failed to infect *Trichosanthes dioica*. The hosts on which positive results have been obtained are new susceptibles.

**Morphology of the fungus.**—Hyphæ thin, white, septate,  $1.7\text{--}2.0\mu$  wide, chlamydo-spores intercalary, in chain ( $2.0 \times 2.0\mu$ ). Sporodochia absent, macroconidia spindle or sickle-shaped, very variable in size, may be one to six septate; one septate  $7\text{--}20 \times 2\text{--}4\mu$ ; two septate  $15\text{--}40 \times 3\text{--}5.5\mu$ ; three septate  $23\text{--}50 \times 3\text{--}6\mu$ ; four septate  $25\text{--}58 \times 3.6\text{--}7\mu$ ; five septate  $28\text{--}62 \times 3.6\text{--}7.5\mu$ ; six septate  $36\text{--}72 \times 4\text{--}7.5\mu$ ; microconidia non-septate  $4\text{--}13 \times 1.6\text{--}3.5\mu$ . Four and five septate macroconidia were most commonly observed.

A culture of the fungus has been deposited in C.M.I., Kew, as No. 100608 and in the Botany Department, University of Allahabad.

We are grateful to Dr. Booth of C.M.I., Kew, for identifying the fungus, and to the Council of Scientific and Industrial Research for the award of a Junior Research Fellowship to one of us (R. K. K.).

Department of Botany, R. K. KAKKAR.  
The University, R. N. TANDON.  
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#### A NOTE ON THE EFFECT OF STAM F-34, ON *KAVADA* (*PANICUM CRUSGALLI*)

*Kavada* (*Panicum crusgalli*) is one of the important monocot weeds which is found growing in abundance in rice fields of Kuttanad. These plants flower earlier than rice and shed the seeds when half ripe. The seeds remain dormant in the soil although the fields are under 2' to 10' of water which may be either saline or fresh during the off-season. These germinate along with rice which is sown after dewatering the field in October-November and this weed grows vigorously and smothers the rice crop. Due to its close resemblance to rice seedlings it is very difficult to identify and eradicate *Kavada* completely. A chemical that would kill *Kavada* without affecting rice would, therefore, be of practical utility to the farmers of this region.

3, 4-dichloropropionanilide (DPA) is a recently introduced chemical to control monocot weeds in rice fields. It is reported to be selective and does not affect rice in any way. A preliminary trial to study the effect of DPA (Stam F-34 kindly supplied by Messrs. Indofil Chemicals Ltd., Bombay) on *Kavada* and rice was undertaken at the Regional Rice Research Station, Monkompu. The details of the trial are given below.

Since attempts to germinate under laboratory conditions the *Kavada* seeds collected in March 1963, were not successful, seedlings at two-leaf stage were collected from a nearby raised iand and planted in cement pots along with equal number of Ptb 10 rice seedlings of the same age. After one month when these produced 4 to 5 leaves Stam F-34 at the rate of 0.55 ml. in

5.5 ml. of water per pot (area 1 sq. ft.) was sprayed on them. The leaves of *Kavada* became flaccid within an hour after spraying and thereafter the seedlings drooped. All the *Kavada* seedlings dried completely within four days whereas the rice seedlings did not exhibit any symptom of injurious effect, excepting some small chlorotic and burnt patches here and there on the leaves (Fig. 1). This did not

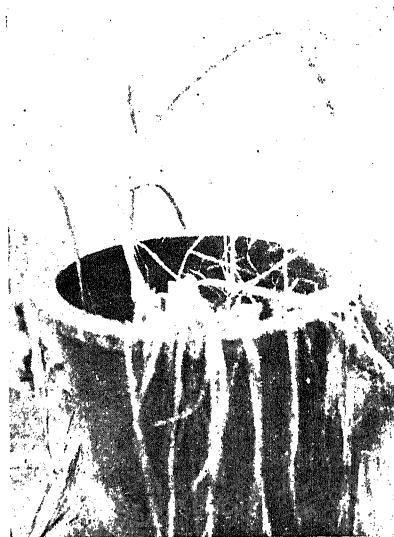


FIG. 1

affect the vigour of the rice seedlings. Details of number of seedlings before and after spraying are given in Table I.

TABLE I

Pot No.	Number of seedlings planted		Number of plants before spraying		Number of plants 4 days after spraying	
	a	b	a	b	a	b
1	10	10	8	5	0	5
2	10	10	9	8	0	8
3	10	10	8	6	0	6
4	10	10	7	8	0	8
5	10	10	10	4	0	4

a—*Kavada*; b—*Rice*.

It would appear that Stam F-34 is effective in controlling *Kavada* in rice field without producing any injurious effect on rice. The concentration used in this trial (about 18 lb. of active ingredient per acre) is very much higher than the recommended dose. It is particularly interesting to note that this chemical even at this higher concentration did not produce any drastic injurious effect on rice. Detailed experiments to find out the optimum quantity and time of spraying to control monocot weeds especially

Kavada in rice fields are being laid out in the field.

The authors are greatly indebted to Shri M. Janardhanan Nair, Director of Agriculture, Kerala, at whose instance the trial was conducted, for his active interest in this study.

Regional Rice N. R. NAIR.

Research Station, A. M. KARTHYAYANI AMMA.  
Monkompu, P. VARADARAJAN.

November 15, 1963.

### STEM-END ROT OF MANGO AND ORANGE FRUITS INCITED BY *DIPLODIA NATALENSIS* POLE EVANS

IN a survey of Delhi markets for diseases of some of the common fruits during 1960-61, both mandarin oranges and *Langra* mangoes were found to be affected by a rot which originated from the stem-end of the fruits. *Diplodia natalensis* Pole Evans was consistently obtained from the diseased peels and pulp of both hosts. Only wound inoculations on these fruits near the base of the stem with pure cultures successfully reproduced the disease. The disease rotted the entire fruit of both hosts within seven days of inoculation. In the case of mango, the affected skin appeared light brown and later olive-brown to black. The pulp under the infected skin turned brown and was somewhat softer than the unaffected flesh. In the case of orange, the infected portions of the rind became dark tan in colour and the pulp was soft and watery.

Although Patel *et al.*<sup>4</sup> have recorded from Bombay *D. natalensis* on mango fruits, there is no mention of any disease in consequence thereof. Cheema *et al.*<sup>2</sup> reported the association of *Glæosporium mangiferæ* with stem-end and other rots in mango varieties under cold storage. Reports from several other countries such as Ceylon,<sup>3</sup> Burma, U.S.A., Mauritius and Philippines show that *D. natalensis* is quite destructive on mangoes in storage and transit.

The stem-end rot of mandarin oranges incited by *D. natalensis* is reported from several countries but the only Indian report stating association of an unidentified species of *Diplodia* with brown-spot infection of the rind with a single citrus fruit near the stem-end is by Cheema *et al.*<sup>1</sup> They observed that this infection was superficial, confined only to the rind, and did not damage the pulp. The stem-end rot

of mango incited by *D. natalensis* and the stem-end rot of orange and the causal pathogen on this host are first records for this country.

The authors wish to express their grateful thanks to Dr. B. L. Chona, Head of the Division of Mycology and Plant Pathology, for his keen interest and encouragement in this work.

Division of Mycology and D. K. CHAKRAVARTY.  
Plant Pathology, D. N. SRIVASTAVA.  
Indian Agric. Res. Inst.,  
New Delhi-12, September 2, 1963.

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### ALBUGO PESTIGRIDIS (VERMA) GHARSE, SP. NOV.

VERMA<sup>3</sup> identified and described *Albugo* occurring on *Ipomœa pestigridis* Linn. as *Cystopus ipomœa-panduratae* (Schw.) Stev. *et Sw.* His identification, however, was based on the morphology of the conidial stage only, as the oosporic stage was not found.

*Ipomœa pestigridis* Linn. affected by *Albugo* shows oosporic as well as conidial stages, the former showing gall formation in the host plant. The gall initials start as peg-like protuberances and gradually enlarge into rounded heads, taking a cerebriform appearance. The oospores are globose, thick-walled, smooth and almost uniform in size, measuring about 22-28  $\mu$  and oogonia 38-50  $\mu$  in diameter.

The oospores of *Cystopus (Albugo) ipomœa-panduratae* (Schw.) Stev. *et Sw.*<sup>2</sup> are subglobose to ovoid, 40-60  $\mu$  in diameter and sparsely tuberculate. The oospores of *Albugo Pratapi* Damle,<sup>1</sup> occurring on *Ipomœa reniformis* Choisy, measure about 36-48  $\mu$  in diameter. Hence it is clear that the *Albugo* on *Ipomœa pestigridis* is neither *Cystopus (Albugo) ipomœa-panduratae* (Schw.) Stev. *et Sw.* nor *Albugo Pratapi* Damle. It is therefore proposed to rename it as a new species — *Albugo pestigridis* (Verma) Gharse sp. nov. The emended description is as follows:

*Albugo pestigridis* (VERMA) GHARSE, SP. NOV.

Conidial pustules hypophyllous, whitish in isolated sori. Conidia globose to subglobose, sometimes slightly squarish in outline, without equatorial thickenings, measuring about 14-21  $\mu$  in length and 14-16  $\mu$  in breadth,

Oospores in cerebriform galls produced on shoots, peduncles, petioles and even midribs: oospores smooth, rounded and thick-walled, yellowish-brown, measuring about  $22-28\mu$  in diameter, more or less loosely invested by persistent warty oogonial wall. Oogonia  $38-50\mu$  in diameter.

*Hab.*: On shoots, peduncles, petiole and midrib of *Ipomœa pestigridis* Linn. causing cerebriform hypertrophy, occurring in September, in Bombay and suburbs.

Type deposited in Herbarium, Cryptogamae Orientalis, New Delhi.

*Albugo pestigridis* (VERMA) GHARSE, Sp. Nov.

Maculae conidiales hypophyllae, albidæ in soris dispersis. Conidia globosa vel sub-globosa, nonnumquam paulum quadratæ in ambitu, abseque incrassationibus æquatorialibus, magnit. ca.  $14-21 \times 14-16\mu$ . Oosporæ in gallis cerebriformibus productæ in surculis, pedunculis petiolis atque etiam in nervis mediis foliorum, læves, rotundatæ atque crassis parietibus præditæ, luteolo-brunnæ diametientes  $22-28\mu$  plus minusve laxè circumdatæ parietibus oogonialibus persistentibus et verruculosi: oogoniis  $38-50\mu$  diam.

Typus lectus in surculis, pedunculis, petiolis et nervis mediis foliorum *Ipomœa pestigridis* Linn. producens hypertrophiam cerebriformem, mense septembri ad Bombay et partes suburbanas eiusdem urbis, et positus in Herb. Crypt. Indiæ Orientalis ad New Delhi Sub numero Gharse.

The writer wishes to express his thanks to Rev. Fr. H. Santapau, Chief Botanist, Botanical Survey of India, for Latin rendering of the diagnosis.

Botany Department, P. S. GHARSE.  
Ruparel College,  
Bombay-16, February 4, 1964.

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#### OCCURRENCE OF TWO BACTERIAL PLANT DISEASES IN SOUTH INDIA

DURING September 1963, a bacterial disease of castor (*Ricinus communis* L.) was observed in the fields of the Agricultural Research Station, Tindivanam, South Arcot District, Madras State. The disease was widespread, occurring on the crops of all ages. The symptoms appeared as

minute, water-soaked, circular lesions on the youngest leaves of the plant. Numerous such spots were found mostly concentrated in the central portion of the leaf blade, the marginal portions being healthy. In the severely infected leaves the blades were transformed into cup-like structures and were reduced in size. In advanced cases the affected portions turned pale brown, drying in irregular patches, involving the thick veins. Such leaves withered in course of time and further growth of the plant was arrested. Invariably the top-most two or three leaves in a plant were affected, the older mature leaves remaining free from infection.

The causal bacterium has been isolated and brought into pure culture. The bacterium is similar in its characters to that described by Patel *et al.*<sup>1</sup> on castor from Bombay State, and so is identified as *Xanthomonas ricinicola* (Elliot) Dowson. This is the first report of occurrence of any bacterial disease of castor in Madras State.

During September 1963 a bacterial disease of jasmine plants, *Jasminum flexile* var. *travancorensense* Gamb., was noted in a place near Trivandrum, Kerala State, where the plants were cultivated in an ornamental garden. The disease appeared as water-soaked, minute lesions on the leaf blades, young and old leaves being equally affected. The lesions were minute, circular, about 1 mm. in diameter, mostly restricted and not enlarging in size. Older spots were dark brown-coloured, circular and about 1 mm. in diameter. There were no chlorotic haloes or cankerous growths in the affected parts. At times numerous spots were found on each leaf blade, but the spots rarely coalesced.

The causal bacterium was isolated and found similar to the one described earlier on *Jasminum sambac* Soland by Rangaswami and Eswaran<sup>2</sup> from Madras State. The bacterium is therefore identified as *Xanthomonas jasminicola* Rang. and Esw. The disease symptoms on the two species of *Jasminum* vary considerably. On *J. sambac* yellowish-green, linear or circular spots, with mosaic-like appearance have been reported, whereas on *J. flexile* var. *travancorensense* only minute water-soaked lesions, which turned dark brown in colour, with no chlorotic haloes, or mosaic-like symptoms were observed in the present case. Perhaps these differences in the symptoms caused by the bacterium are due to varietal reactions.

Microbiology Laboratory, G. RANGASWAMI.  
Faculty of Agriculture,  
Annamalai University,  
Annamalainagar, Madras State,  
December 12, 1963.

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#### PRESENCE OF FUSARIC ACID IN WILT-AFFECTED PIGEON- PEA PLANTS

THE role of fusaric acid as a vivotoxin in several wilt diseases caused by different species of *Fusarium* is now recognized.<sup>1-4,6</sup> The production and systemic translocation of this substance in cotton plants infected with *Fusarium oxysporum* f. *vasinfectum* (Atk.) Sny. and Hans<sup>2,4</sup> and in tomato by *F. oxysporum* f. *lycopersici*<sup>1,3</sup> has been demonstrated by several workers. Recently presence of fusaric acid in banana plants infected with *Fusarium oxysporum* f. *cubense* has been shown.<sup>5</sup> The production of fusaric acid in pigeon-pea plants [*Cajanus cajan* (L.) Millsp] infected with *Fusarium lateritium* f. *cajani* (Padw.) Gord. has now been demonstrated here.

A susceptible variety of pigeon-pea, T. 105, was inoculated with a mycelial and spore suspension of a virulent isolate of the fungus and when wilt symptoms appeared 30 to 40 days after seed planting, the plants were pulled out, washed and frozen overnight for preparing extracts. The roots, shoots and leaves were separated and all these infected parts were cut into small pieces, crushed and homogenised separately in a waring blender with sterilized distilled water. The samples were centrifuged at 4,000 r.p.m. for half an hour. The supernatant obtained from each sample was concentrated tenfold by distillation under vacuum at 25° C. The concentrated extracts obtained in this manner were used as samples for fusaric acid assay. Similar samples were also prepared from healthy plants of the same age.

Presence of fusaric acid in the samples was determined by the paper chromatographic

method as outlined by Page.<sup>5</sup> A small quantity of each sample was applied to Whatman No. 1 paper strips along with a 0.01% solution of fusaric acid as standard. The samples obtained from roots, shoots and leaves of healthy plants were used as controls. A 4:1:5 mixture of *n*-butanol, acetic acid and water was used as a solvent. One-dimensional descending chromatograms were allowed to run for 18 to 22 hours in the solvent at room temperature (22-25° C.). After drying, the chromatograms were sprayed with 0.1% rubeanic acid in acetone. The copper-fusaric acid complex was detected as an olive-gray spot with R.f. value 0.2. Presence of fusaric acid was detected in all the affected parts of the plants including roots, stems and leaves. No spots were detected in case of control samples obtained from healthy plants. Presence of fusaric acid in the infected plants indicates that this toxin is produced by the pathogen and probably it also plays an important role in the disease syndrome as postulated in case of other wilt diseases.<sup>1-6</sup> The initial symptom of the disease in this case is also similar to fusaric acid injury and this gives further evidence that this substance is responsible at least for a part of damage to host tissues caused by *F. lateritium* f. *cajani* in pigeon-pea plants.

The authors are thankful to Dr. S. Naef-Roth of the Federal Institute of Technology, Zurich, Switzerland, for supply of pure fusaric acid.

Dept. of Plant Pathology, G. P. SINGH.  
Govt. Agricultural College,  
Kanpur,

and

Regional Research Centre, AKHTAR HUSAIN.  
(Oilseeds and Millets),  
I.C.A.R., Kanpur,  
December 18, 1963.

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 REVIEWS
 

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**Stellar Interiors.** By D. H. Menzel, P. L. Bhattacharjee and H. K. Sen. (Chapman & Hall, London), 1963. Pp. 317. Price 65 sh. net.

The book is the sixth volume of a series dealing with astrophysics which has been designed to be suitable both for specialists and students and to assist in the teaching of the subject and its general advancement. The present volume is a joint production of three authors; the first-named is a practical astronomer, the second a professional mathematician and the third a research physicist. The entire subject is covered in fourteen chapters and the book is of modest size. Considering the highly recondite character of the considerations developed in the successive chapters of the volume, its brevity is commendable. At the same time, the didactic purpose is continually held in view and is admirably fulfilled.

The classic works of Eddington on "The Internal Constitution of Stars" (1926) and of Chandrasekhar on "Stellar Structure" (1938) will naturally be referred to and studied in detail by those who wish to delve deeply into the fascinating field of theoretical astronomy which concerns itself with the nature of the material and the processes taking place in the interior of stars. As a survey of the current state of knowledge in the field and as an introduction to further study and research, the reader will find the present volume quite useful.

C. V. R.

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**The Solar Corona.** Edited by J. W. Evans. (Academic Press, New York and London), 1963. Pp. 344. Price \$14.00.

The visual observation of the corona seen extending beyond the edge of the sun in a total solar eclipse is rightly regarded as one of the most exciting experiences of a lifetime. These occasions are however few and far between. The techniques which have been developed by Lyot and others for observations of the corona at other times have therefore been most helpful in advancing our knowledge of the nature of the coronal light.

Many surprising facts have come to light, regarding the sun's corona, viz., the temperature of the material in it is of the order of a million degrees centigrade, that a substantial part of

the observed luminosity arises from the scattering of sunlight by swiftly moving free electrons, and that the well-defined emission lines observed in the spectrum of the corona have their origin in the light emitted by highly ionised atoms of various metallic elements, notably iron and nickel. So far from the interest in coronal research having evaporated as the result of these elucidations of the nature of the corona, it persists undiminished. In particular, the relationship of the corona to other forms of solar activity, viz., prominences, flares, magnetic fields, etc., evidently calls for elucidation by further factual studies.

The present volume is a report of a symposium of an international astronomical union held in August 1961 in New Mexico. Sessions were held on three days and in all, forty-four communications are reported in the volume. It is not possible in this review to deal with all the communications. It would suffice to say that the volume will be of the deepest interest to all interested in the study of the sun and its activities.

C. V. R.

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**Reports on Progress in Physics, Vol. XXVI.**

Edited by A. C. Stickland. (The Institute of Physics and the Physical Society, 47, Belgrave Square, London, S.W. 1), 1963. Pp. 472. Price £ 5.

*Reports on Progress in Physics* for the year 1963 contain the following eleven articles:— Lattice vibrations, by W. Cochran; Studies in the preparation and behaviour of nearly perfect metal surfaces, by E. Menzel; Generation of high magnetic fields, by D. Bruce Montgomery; X-ray crystallography of large molecules of biological importance, by A. C. T. North; Van Allen particles, by H. Elliot; Wavelength measurements in the vacuum ultra-violet, by B. Edlén; Atmospheric tracers and the study of the general circulation of the atmosphere, by P. A. Sheppard; Ultra-high-speed photography, by K. R. Coleman; Macroscopic symmetry in space-time, by R. R. Birss; Electronic properties of liquid metals, by N. E. Cusack; and Theory of irreversible processes, by G. V. Chester.

The above enumeration of the titles will give a general idea of the range of fields covered in this *Report*. While some of the titles are those

under which reviews had appeared in earlier volumes of the series, the others are new and appear here for the first time. They are of special interest as vigorous research have been going on in them in recent years. All the reviews present and discuss the latest results in the subject concerned and bring the references to nearly the end of 1962.

Cochran in his article on lattice vibrations discusses the recent techniques of thermal diffuse scattering of X-rays and the spectroscopy of thermally scattered neutron which have yielded new information about interatomic forces in crystals. In the light of the new results the so-called classical theory has become outmoded and it is time that a review is taken, especially in its application to metallic crystal.

Another article on crystal physics is the one on macroscopic symmetry in space-time by He. It is well known that classical crystallography allocates all possible crystal forms to one of 32 crystal classes or point groups. The inclusion of translational symmetry increases this number to 230 which in fact represents the number of distinguishable patterns which can be formed in three dimensions by the periodic repetition of a unit taken as a motif. If, further, the units which are otherwise identical, can be distinguished from each other on some other basis, say black or white, the number of distinguishable patterns in three dimensions is increased to 1491. The case of ferromagnetic, ferrimagnetic or antiferromagnetic crystal is a point in question. The orderly distribution of spin magnetic moments in these crystals constitutes a repetitive feature and so their physical properties cannot be completely characterized by allocating them to one of the 230 spatial symmetries, which from this point of view can be designated as non-magnetic symmetries. Burs in his article considers the non-magnetic symmetries from the point of view of general (translational) transformations in four-dimensional space-time and deduces the magnetic symmetries. It turns out that the total number of magnetic symmetries is 1421 (230 + 1191). The article further illustrates how the forms of tensors characterizing the macroscopic properties of a crystal may be predicted from a knowledge of its symmetry in space-time.

An article of meteorological interest is the one by Sheppard on atmospheric tracers. An accurate knowledge of the circulation of the atmosphere at various heights is the major problem of meteorology. The method that is easily suggested and at the same time whose technique

has been rapidly developed is to follow the course of a suitably chosen particle (tracer particle) in the atmosphere. A tracer is ideally an entity which preserves its identity as it moves with the air from a known source, where the tracer is created or otherwise introduced into the atmosphere, to a known sink where it is destroyed or removed from the atmosphere. In this sense a balloon is, of course, a tracer. Besides, we have molecules like  $H_2O$ ,  $CO_2$ ,  $O_3$ , He,  $N_2O$ , etc., aerosols, radioactive nuclei which can act as tracers. The article in question presents information so far collected on atmospheric circulation by this method, and discusses their application in relation to the circulations in the troposphere and stratosphere, and to transfer between these domains.

The Van Allen particles are the energetic charged particles trapped in the geomagnetic field. Elliot summarizes the main facts concerning the dynamics of the trapped particles and discusses briefly available data on their intensity distribution, energy spectrum and origin.

The present volume of the *Reports* maintains the standard of the previous volumes and is a necessary acquisition to all scientific libraries. It is satisfying to know that the publishers will supply the separate articles in the volume at 7sh 6d. each.

A. S. G.

#### Biochemistry of Industrial Micro organisms.

By C. Rambo and A. H. Rose. (Academic Press, London W 1), 1963. Pp. xix + 708. Price 147sh

The contents of contributions on different aspects of industrial fermentation by workers in different fields. The title *Biochemistry of Industrial Micro organisms* may be misleading as many of the topics cover nutritional and industrial aspects rather than biochemistry of fermentation. A title of a more general character such as industrial fermentations would have been more appropriate.

As it happens in a book of this type some sections such as those on 'Vitamins', 'Antibiotics' and 'Polysaccharides' are well presented and some others indifferently.

The article on 'Microbial Food' seems rather out of place. The article on 'Fermentation Processes' covers familiar grounds and details therein are to be found in any standard textbook on fermentation. As such it seems largely superfluous.

In the chapter on the production of organic acids, by mould a detailed discussion of the basic pathways of glucose metabolism seems rather

unnecessary. This contrasts with the incomplete manner in which the literature under review has been treated. The omission to mention aconitase inhibition during citric acid accumulation is surprising. Further, the glyoxylate bypass is not found to operate during the production of citric acid from sugar. The author of the chapter appears to have no acquaintance with the many papers published on this subject in 1955-61.

The book should be a useful addition to libraries but is priced rather high for acquisition by individuals. R.

**Methods of Enzymatic Analysis.** Edited by H. U. Bergmeyer. (Verlag Chemie, Academic Press, New York-3), 1963. Pp. xxiii + 1064. Price \$ 30.00.

Enzymes are used extensively at the present time as analytical tools, since many of them are now available in a high state of purity. The book under review contains contributions from over hundred authors who have had specialised experience in their particular field of study, and contains working directions for carefully tested enzymatic procedures. It provides the biochemist, the physiologist, the botanist and the agricultural chemist, reliable experimental directions based on latest advances for the assay of many compounds of biological interest.

The book is divided into four sections, the first of which describes the basic principles underlying enzymatic analysis, techniques of measurement and procedures for disintegration of cells and tissues. This is followed by the two main sections, the first of which gives detailed methods for the estimation of substrates such as monosaccharides and their derivatives, disaccharides and polysaccharides, one, two and three carbon compounds, citric acid cycle intermediates, proteins, peptides, fatty acids, lipids, steroids, nucleosides, purines, pyrimidines, co-enzymes and related substances. The third section deals with measurement of activity of such enzymes as aldolases, dehydrogenases, esterases, proteases and transaminases; methods for the histochemical detection of enzymes are also included.

In the last section, details are given of the commercially available enzymes, coenzymes, substrates and complete reagent kits. Emphasis is laid throughout on practical aspects and useful information provided in regard to sources, stability and criteria of purity of the various

reagents. As Professor Bucher has so aptly stated in his foreword, "an analytical method is of value when its specificity, reproducibility and sensitivity are high and when the expenditure of labour, time and material are low". Though greater emphasis is laid on equipment, chemicals and special reagents easily available in Europe, alternate sources of supply in U.K., U.S.A. and Japan are also mentioned. There can be no doubt that the wealth of information provided in this volume will be a great asset to any practising scientist interested in the use of a wide variety of enzymes in the accurate analysis of the various constituents of the living cell. P. S. SARMA.

#### Books Received

*Handbuch der Kolorimetrie (Band II) Kolorimetrie in der Pharmazie.* By B. Kakac and Z. J. Vejdelek. (Veb Gustav Fischer Verlag, Jena, Villengang 2), 1963. Pp. xv + 1128. Price DM. 83.20.

*Theory of Elasticity.* By M. Filonenko-Borodich. (People's Publishing House P. Ltd., Rani Janshi Road, New Delhi-1.) Pp. 378. Price Rs. 6-00.

*Introduction to Physics.* By A. Kitaigorodsky. (People's Publishing House P. Ltd., Rani Janshi Road, New Delhi-1.) Pp. 719. Price Rs. 8-00.

*Observation and Interpretation in the Philosophy of Physics—With Special Reference to Quantum Mechanics.* Edited by S. Korner. (Dover Publications, New York-14, N.Y.), 1964. Pp. xiv + 218. Price \$ 1.60.

*Grundriss der Biologischen Statistik.* By Erna Weber. (Veb Gustav Fischer, Verlag, Jena), 1964. Pp. xii + 582. Price DM. 45.

*Recent Advances in the Embryology of Angiosperms.* By P. Maheshwari. (International Society of Plant Morphologists, University of Delhi, Delhi-6), 1963. Pp. x + 467. Price not given.

*The Genetics of the Silkworm.* By Yataro Tazima. (Logos Press Ltd., 2, All Saints Street, London N. 1), 1964. Pp. xii + 253. Price 50 sh.

*The Flora of Delhi.* By J. K. Maheshwari. (Council of Scientific and Industrial Research, Calcutta-12), 1963. Pp. viii + 447. Price Rs. 28-00.

*Introduction to Practical Infra-red Spectroscopy.* By A. D. Cross. (Butterworth & Co., 4 and 5, Bell Yard, London W.C. 2), 1964. Pp. xiii + 86. Price 17 sh. 6d.



## SCIENCE NOTES AND NEWS

### Award of Research Degree

Sardar Vallabhbhai Vidyapeeth has awarded the Ph.D. Degree in Chemistry to Shri R. S. Patel and Shri M. R. Patel for their theses entitled "Properties of Amylose Acetate Molecules in Dilute Solutions" and "Studies on the Arylamides of Acetoacetic Acid" respectively.

### Proceedings of the Symposium on Plant and Animal Viruses

A symposium on 'Plant and Animal Viruses' was held at Cuttack in January 1962. The Proceedings of the Symposium have been published as *Bulletin No. 24, 1963, of the National Institute of Sciences*. It contains seventeen papers presented at the symposium and the discussions that followed. The papers focus attention on the progress of work that is being done in India in different aspects of plant and animal virology, such as virus-vector relationships, spread and control of virus diseases, virus inhibitors, biosynthesis of viral nucleic acids, etc.

The Bulletin contains 248 pages and is priced Rs. 19.37 nP.

### Science Progress

With the January 1964 issue *Science Progress* appears with a more attractive cover and a more pleasing type and lay-out. The aims of *Science Progress* have been to present to the scientist reviews of topics which are actively advancing. The present Editors intend to resist any trend to publish specialist articles, but instead will aim at publishing articles written by scientists for scientists, articles that are in a readable and assimilable form for those working in other disciplines. Emphasis will be on that part of science which is on the border line between the disciplines.

The new number with the facelift and inside daintiness contains the following titles in the Articles Section: (1) Luminescence in Solids, by G. F. J. Garlick; (2) Nucleic Acid Structure, by Watson Fuller; (3) New Noble Gas Compounds, by R. D. Peacock and J. H. Holloway; (4) Science and Society in China and the West, by Joseph Needham; (5) The Transuranium Elements, by K. W. Bagnall.

### Galvanostalametry : Electrochemical Phenomena Detector

Galvanostalametry, a technique involving the negative pressure in columns of liquid, is now

being adapted to investigations of electrochemical phenomena by the National Bureau of Standards. In galvanostalametry (derived from galvano, meaning current, and stalao, meaning to drop) a vertical column of liquid is suspended in an evacuated glass tube by adhesion to the closed top of the tube. If during electrolysis a minute quantity of gas forms at an electrode at the top of the tube, the column of liquid drops abruptly. Galvanostalametry provides an effective means for measuring electrolytic and time parameters by using the formation of gas at an electrode as an indication of an electrode reaction.

The apparatus employed consists of a metre long glass tube, closed at the top, with a reservoir of approximately a litre capacity attached to the bottom giving the apparatus a "J" shape. Two electrodes are usually sealed in the top of the vertical tube or, if the reaction of only one electrode is of interest, the second electrode may be inserted in the reservoir.

The source of electricity varies with the type of measurement. For example, if the process involves a steady current, a six-volt battery is adequate. On the other hand, higher potentials are needed for experiments involving condenser discharges. A potentiometer and other appropriate instruments are employed for measuring current, voltage, charge and time involved in dropping the column. An experiment is begun by introducing a hot electrolyte into the mouth of the reservoir and evacuating the apparatus until the solution reaches room temperature. This procedure removes most of the dissolved gases and provides a stable suspended column. The evacuated apparatus is then inverted to fill the tube. When the apparatus is returned to an up-right position, the electrolyte remains suspended at the top of the tube by virtue of the adhesion between the electrolyte and the top surfaces of the tube. The electrolyte, thus under tension, may remain suspended indefinitely. However, it will suddenly drop when microscopic gas bubbles form on the electrodes during electrolysis.—(*Jour. Frank. Inst.*, 1964, 277, 187.)

### Nature of Argillaceous Odour

That many natural dry clays and soils evolve a characteristic odour when breathed on, or moistened with water, is well known. The "smell of rain" is a familiar sensation. Such odour is referred to as argillaceous odour. It

will be interesting to note that the production and concentration of argillaceous odour from baked clay have been, for many years, the basis of a small perfumery industry centred near Kannauj, U.P., India. Baked clay discs, exposed under the open sun during the hot summer months of May and June, are collected before the wet season and are steam-distilled and the vapours containing the odour and associated products are absorbed in sandalwood oil. The perfume so obtained is known as "matti ka attar" or earth perfume.

According to Bear and Thomas of C.S.I.R.O. Division of Mineral Chemistry, Australia, examination of a wide diversity of rocks and mineral aggregates has indicated that the capacity to evolve a characteristic odour on moistening the previously dry material is by no means confined to clays. To a varied extent it is so general that the majority of silicate minerals and rocks, largely irrespective of kaolinization or porosity, exhibit the phenomenon. In their examination the test substances were ignited at 600° C. for a short period in a muffle furnace to destroy any organic or microbiological contamination, and each sample was afterwards tested for lack of odour on moistening with water. The samples were then exposed to the atmosphere for varying periods of time under warm dry conditions and the presence or absence of odour, on subsequent dampening, was used as a basis of classification regarding the capacity of the source material to produce the typical smell.

The investigators have proposed the name "petrichor" for this apparently unique odour which can be regarded as an "ichor" or tenuous essence derived from rock or stone. Their results on the examination of petrichor extracted from different source materials such as basaltic scoria, kaolinized granite, etc., by steam distillation or by solvent extraction, and subsequent chemical and infra-red analysis of the extracts are published in a communication to *Nature* (March 7, 1964).

The most obvious explanation of the various observed phenomena is that petrichor represents an accumulation of substances fortuitously present in the atmosphere which have been adsorbed by materials known to be active in that capacity. On the basis of experimental conditions a direct biological origin seems improbable. In addition to adsorption catalytic

activity may also be involved in the synthesis of the substances concerned in the production of the odour.—(*Nature*, 1964, 201, 993.)

### Observation of a Hyperon with Strangeness minus Three

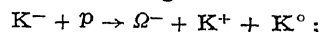
A communication under the above title appears in the *Physical Review Letters* (24 February 1964) over the names of thirty-three authors from Brookhaven National Laboratory. The authors report the observation of an "event" which they believe to be an example of the production and decay of the particle  $\Omega^-$  (Omega minus).

Recent theories of strong reactions have predicted the existence of a hyperon or "strange" particle called  $\Omega^-$ . It is a negatively charged isotopic singlet with "strangeness" minus three, and of expected mass about 1680 MeV/c<sup>2</sup>. The strangeness numbers introduced by Murray Gell-Mann for nucleons, mesons and hyperons, successfully predict which particles should arise and which should not when two particles interact. Strangeness is conserved in strong interactions, i.e., those in which new particles are formed, but is not conserved in weak interactions, where particles simply decay into other particles.

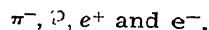
The existence of  $\Omega^-$  has been cited as a crucial test of the theory of unitary symmetry of strong interactions.

The BNL 80-inch hydrogen bubble chamber was exposed to a mass-separated beam of 5.0 BeV/c K<sup>-</sup> mesons at the Brookhaven alternate-gradient synchrotron (AGS). About 10,000 pictures were taken containing a total K<sup>-</sup> track length of about 10<sup>6</sup> feet. These pictures have been partially analyzed to search for the more characteristic decay modes of the  $\Omega^-$  particle.

The interpretation of the event leading to the production of  $\Omega^-$  is given as :



The decay of the new particle takes place in five stages, going through the production of Xi zero, Lambda zero and Pi zero, and finally yielding



The mass of  $\Omega^-$  is computed to be  $1686 \pm 12$  MeV/c<sup>2</sup> and its proper lifetime has been calculated to be  $0.7 \times 10^{-10}$  sec.—(*Physical Review Letters*, 24 February 1964.)

# STARS, NEBULAE AND THE PHYSIOLOGY OF VISION

SIR C. V. RAMAN

ON any clear dark night we see the sky studded with stars, a few very bright ones, many more not so bright, and a much larger number of faint ones. They appear to us as points of light standing out of a dark background and possessing no visible extension. Numerous as the stars thus visible to the unaided eye are, their number is but a fraction of the multitude of stars revealed to our eyes when we are aided by such a modest item of equipment as a pair of binoculars. The stars made visible by using more powerful instrumental aid are even vastly more numerous. The reason is evident, *viz.*, that the stars which appear faint are far more numerous than those which are bright and the same situation extends without limit to fainter and still fainter stars. This may be illustrated by reference to the actual numbers determined and listed by the painstaking labours of astronomers in their published star-catalogues. The so-called bright stars whose visual magnitude is less than 6.5 are about 9,000 in number, those of magnitude less than 8.5 number a quarter of a million and those of magnitude less than 10.5 more than a million. The scale of visual magnitudes adopted by astronomers is defined by the rule that the ratio of the brightnesses of two stars whose magnitudes differ by 5 is 100.

We may here ask ourselves two questions. Why are we unable with our unaided vision to perceive stars in the sky whose visual magnitude is more than, say six? Why does it become possible to observe stars of higher magnitudes with telescopic aid? Answers to both of these questions are given if it be assumed that for the eye to perceive a star, the light-flux reaching its image on the retina should exceed a specifiable minimum. This light-flux may be taken as proportional to

the area which admits the light entering the eye. For the unaided eye, this would be the area of its pupil and when there is optical aid, this would be the area of the objective of the telescope. On this basis, an increase of the diameter of the objective by a factor of ten would enable stars to be perceived whose magnitude is larger by 5.

We shall now proceed to evaluate the light-flux reaching us from stars of various magnitudes. The basis of the calculation is the known value of the energy received by us from the Sun and the known value of the Sun's luminosity relative to the light received from the stars. "The total output of the Sun between  $\lambda$  5480 Å and  $\lambda$  5380 Å is  $5.17 \times 10^{31}$  ergs sec.<sup>-1</sup> The amount received per square centimeter at a distance from the Sun equal to the mean radius of the Earth's orbit or  $1.496 \times 10^{13}$  cm., is  $1.838 \times 10^4$  ergs cm.<sup>2</sup> sec.<sup>-1</sup> The Sun's International photovisual magnitude is 26.81 according to Kuiper. It therefore delivers to the Earth  $10^{19.730}$  times as much light as a star of zero magnitude in every wavelength if the star has exactly the same spectral type as the Sun. Hence the amount received per square centimeter per second per 100 angstroms at  $\lambda$  5430 Å from a star of type dG0 and of magnitude, 0<sup>m</sup>, 001Pv is  $3.37 \times 10^4$  ergs; and the logarithm of the energy received from any star of this spectral type is  $7.53 + 4m_{pv}$ ." The above is quoted from the book on "The Outer Layers of a Star" by Woolley and Stubbs, Chapter XIII, page 274, where the corrections needed for stars of other spectral types are also listed.

In vision, we are chiefly concerned with the spectral region between 5000 Å and 6500 Å, as the luminous efficiency of radiation becomes rather small outside those

limits. It is therefore sufficient to consider the energy appearing between these limits in the spectrum of a star in seeking to explain its visibility. In the spectral energy curves for a perfect radiator at  $5740^{\circ}\text{K}$ . which is the effective solar temperature, the wavelengths  $5000\text{ \AA}$  and  $6500\text{ \AA}$  are not far from the wavelength at which the radiation is a maximum. We shall therefore be justified in taking the flux of energy which determines the visibility of a star of the same spectral type as the Sun to be fifteen times the energy flux for a range of  $100\text{ \AA}$  quoted above. This may conveniently be expressed in terms of the quantum of energy corresponding to the wavelength  $5600\text{ \AA}$  which is that of maximum luminous efficiency. The number of light-quanta per second reaching the unaided eye from stars of various magnitudes has been thus calculated and shown in Table I, the area of the pupil of the eye being taken as 50 square millimetres.

TABLE I  
*Light-flux received by the eye*

Magnitude of star	Quanta per second	Magnitude of star	Quanta per second
0 <sup>m</sup>	7,10,000	6 <sup>m</sup>	2,900
1 <sup>m</sup>	2,90,000	7 <sup>th</sup>	1,140
2 <sup>m</sup>	1,14,000	8 <sup>m</sup>	450
3 <sup>m</sup>	45,000	9 <sup>th</sup>	180
4 <sup>m</sup>	18,000	10 <sup>th</sup>	71
5 <sup>m</sup>	7,100	11 <sup>th</sup>	29

We may now proceed to consider the significance of the figures listed in Table I against the increasing orders of magnitude of the stars. If it be assumed that a single quantum of light if actually taken up by the visual receptors and passed on to the visual cortex could produce a detectable sensation, it is clearly necessary that the quanta should follow each other in rapid succession to enable the eye to perceive a star *steadily*.

30 quanta following each other in each second would probably suffice to produce a lasting impression. Actually, the Table shows that a 6th magnitude star (which experience shows can just be perceived) has a light-flux of 2,900 quanta per second, while stars of higher magnitude which have a smaller light-flux are not perceived at all. A reasonable explanation that can be offered for the facts is that the visual receptors take up or absorb only about 1% (averaged over the spectral range under consideration) of the light-quanta which reach them and transmit the impulses to the cerebral centres, while the rest go through unabsorbed to the pigment epithelium behind the retina. The number of quanta taken up and thus passed on would then just suffice in the case of a 6th magnitude star to enable us to see it steadily, while for stars of higher magnitude, it would be inadequate to produce such a result.

When we view the sky fixing our eyes on a particular star located on it, we have nevertheless no difficulty in recognising the presence of numerous other stars both far from and near to the one so regarded. The question then arises whether the brightness of any two stars as visually perceived in these circumstances depends to any noticeable extent on their positions relative to each other in the field of view and whether the visibility of any particular star depends markedly on its position in the field with respect to the point at which vision has been fixed. Both of these questions have an important bearing on the known variation in the anatomical structure of the retina as we pass from the fovea outwards. No answers can be given to these questions which are worthy of credence unless they are based on systematic observations and a careful comparison of our subjective impressions with the objective record furnished by photographic charts of the part of the sky under observation. If no effects of the kind

indicated actually exist, it might reasonably be inferred that the visual process by which a point source of light is perceived does not vary sensibly in its nature over the area of the retina.

Other interesting questions arise which can only be answered by the results of specific investigations. It is familiar knowledge that when the night sky presents a background of continuous illumination, as for example, when the Moon is well above the horizon, the visibility of the fainter stars is seriously impaired. What is the precise origin of this effect, and how is the diminished visibility related quantitatively to the strength of the diffuse illumination of the sky? Then, again, is it possible to perceive quantum fluctuations in the visibility of faint stars? Here the difficulty presents itself of the fluctuations in brightness of stars due to the turbulence of the atmosphere which would also be present and interfere with the observations.

Having discussed the visibility of the stars of various magnitudes, we pass on to consider the highly interesting question of their colours. As seen by the unaided eye, a few of the very brightest stars show a hint of colour. But the vast majority of the stars appear to our unaided vision as mere specks of light of greater or less brightness and give no indication of the great differences in the spectral character of the light which they emit and the very large differences in the effective surface-temperatures inferred from these spectral characters and also from the luminosities as measured by photoelectric and photographic methods using colour filters to isolate different parts of the spectrum. The effective surface-temperatures range from  $25000^{\circ}\text{K.}$  for stars of the spectral class BO,  $5520^{\circ}\text{K.}$  for those of spectral class G5, to  $2710^{\circ}\text{K.}$  for the spectral class M5. These enormous differences show up very clearly when the luminosities of the stars are determined using colour

filters as stated above; the colour-index of a star is the difference between its magnitudes in two colours. It is frequently given as the blue *minus* the yellow or visual ( $B - V$ ) magnitude. This difference may be as much as two whole magnitudes for a star belonging to the spectral class M.

We may, therefore, well ask ourself the question why our unaided vision fails to reveal the great differences in colour which might have been expected in the circumstances stated above. Here, a significant remark may be made, *viz.*, that the colours of the fainter stars become distinctly more manifest when the stars are viewed through a telescope with an adequate aperture. Colour-differences between the two components of double stars also become noticeable with such aid and are indeed to be found indicated in the published catalogues of various observers. It is obvious from this that the magnitude of the light-flux reaching the retina from a star not only determines the visibility of the star and its brightness or luminosity, but also plays a highly important role in the perception of colour. We are indeed led to the inference that as the number of light-quanta received per second by the eye from a light-source progressively increases, the sensations of luminosity and of colour develop *pari passu* and become more pronounced. When the light-flux reaching the eye is small, we perceive a dim and characterless luminosity. As the light-flux increases, our perceptions develop into a bright and colourful sensation.

A great many years ago, the author visited the Mount Wilson Observatory near Pasadena and enjoyed the privilege of sitting at the eyepiece end of the 60-inch reflector one night and of the 100-inch reflector another night. Amongst the objects chosen for viewing through these telescopes were the famous Ring nebula in Lyra and the Great nebula in Orion well known to all amateur astronomers. The writer was familiar with the

appearance of these objects as seen through a 7-inch refractor available to him at Calcutta and was enormously impressed by what he saw of them through the great telescopes at Mount Wilson. The Ring nebula in Lyra exhibited flaming colours changing progressively from the external edge of the ring to its inner margin. The Great nebula in Orion which in smaller instruments appears as a shapeless patch of light without noticeable colour is seen with the sixty-inch as a blazing area of variegated colour determined by the light-emission of the gases of which it is composed. The impression left on the writer by these experiences was so vivid that it was recalled and a special reference made to it in a broadcast on "The Stellar Universe" given several years afterwards at Madras. This appears in a printed collection of the author's radio-talks on various aspects of science published by the Philosophical Library, Inc., of New York in the year 1951.

When we look at a star directly or when we view a star or a nebula through the eyepiece of a telescope, we make use of the region of the fovea in the retina. It follows that everything that has been stated above regarding the perception of light and colour refers to the functioning of our eyes in photopic vision, so termed by writers on physiological optics. It is a fact that our eyes are capable of functioning in very dim light and enable us, for example, to find our way

through the countryside on a dark night when the landscape is lit only by starlight. This is scotopic or dim-light vision. But if, in the same circumstances, we look up and view a star which is a concentrated point-source of light, it is photopic and not scotopic vision that is functioning. That we are unable without optical aid to see stars of magnitude higher than six or to perceive the colour in any except the very brightest of stars are therefore characteristic features of photopic vision.

The real distinctions between photopic and scotopic vision are that scotopic vision does not function except when the eyes have been prepared for it by having been rested in the dark for an adequate period, and scotopic vision does not at all function in red light even after such a period of rest. It is often stated and generally believed that scotopic vision is achromatic while photopic vision alone is associated with the possibility of observing and recognising colour. Since, as we have seen, even in photopic vision, colour sensations become enfeebled at low levels of luminosity, likewise it is to be expected that they would be extremely weak at the very low levels of illumination at which scotopic vision functions. But that they are not wholly absent in scotopic vision even at such levels has already been noticed and remarked upon by the writer in an earlier publication (*Memoir No. 125 of the Raman Research Institute*, Vol. VIII, 1960, page 11).

## LIMITATIONS ON THE USE OF ISOTOPES IN REACTION MECHANISMS\*

## Part I. Some General Considerations

S. V. ANANTAKRISHNAN

*Department of Chemistry, Madras Christian College, Tambaram, Madras 45*

THE use of isotopes in the study of many reactions is now so general that an appraisal of the validity of the method in deciding on a reaction mechanism is warranted. The general approach to the problem is that of Bigeleisen and Goppert Meyer<sup>1</sup> who obtain for the ratio of the rate constants following the transition state method an equation

$$\frac{K_1}{K_2} = \frac{\nu_{1L}^\ddagger f_{af} b}{\nu_{2L}^\ddagger f^\ddagger}$$

where the partition functions are expressed as functions of the frequency of the bond involved and some factors depending on the symmetry of the system undergoing the change. Two complications were recognised quite early. The transmission coefficient along the reaction co-ordinate depends on the mass of the activated complex and this may be partly destroyed in any averaging process. Further, tunnelling effects cannot always be excluded.<sup>2</sup> Where secondary effects alone are involved, the assumption is made that only stretching frequencies need to be considered. The stretching force constant in the complex may decrease by a factor of two and it is possible to calculate from the masses the appropriate isotopic shifts.

Now, if only one bond breaking step is involved, the rate constants should be such that the difference in activation energies should be essentially the difference in zero point energies of the isotopes. Unfortunately, no data to test this can be had from the reported rate measurements. Evidence is also not wanting to show that the bond-stretching force constant alone is inadequate. Bigeleisen and his associates<sup>3</sup> have shown that even in the case of vapour pressures, *cis*-, *trans*-, and *gem*-dideutero ethylene show values which clearly showed values for hindered rotation about the C=C axis where one has to take into account perturbation by out of plane vibration and rotation-vibration coupling.

A further point to be noticed is that the variations of both the parameters of the Arrhenius rate equation show variations in

isotope exchange studies under homogeneous catalysis in the reduction of the dichromate ion by hydrogen. Though associated with the rate-determining step, the values are not in the same direction<sup>4</sup> with different catalysts.

A difficulty common to all isotope studies is the absence of experimental data on the vibration frequencies of the bonds involved in the reaction. This is particularly the case with the substituted compound and the values have invariably to be computed. Isotope effects are dependent on the magnitude of spectral shifts. These in turn are linked up with the vibrational frequencies and their modes. Temperature, mass difference and atomic mass are all factors to be reckoned with in analysing the effect of substitution. There is again the symmetry number in the Bigeleisen equation. Obviously this can have meaning only with reference to the transition state. One has to expect this term to be related to the topology of the transition state and more than one alternative will have often to be considered. Where closely related compounds are studied, the effect of substitution has been shown by Fairclough and Hinshelwood<sup>5</sup> in a general parallelism between the two Arrhenius parameters but instances are not wanting where this breaks down.<sup>6</sup> The rate constant is a composite term involving both the parameters and using the rate constant alone for comparison can lead to incorrect inferences. While the activation energy is probably related to the bond broken in the rate-determining step, the entropy term has to be in relation to the topology of the transition state. If the two factors function in opposite directions, isotope effect can be negligible. Very accurate experimental data are needed to justify even a limited comparison with rate constants. Taking all factors into account, rate constants are not often accurate to more than 2%. An error of this order can lead to an error in the activation energies of 750 calories or of the entropy factor by about 1 entropy unit or both. Where available, frequency shifts are not very much more accurate and any inference has to be subject to this limitation.

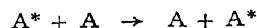
We can see this by examining a few electron or atom transfer reactions. Whether it is in

\* Contribution to a symposium on Radiation Chemistry arranged by the Department of Atomic Energy in March 1964.

the gas phase or in condensed phase we find that isotope effects do not give an unequivocal answer to the reaction mechanism. The use of tracer atoms alone is inadequate with reactions in solution but where aquo-complexes or related structures are involved, some information can be had where the reactions have been studied in both water and in deuterium oxide. Krishnamurti<sup>7</sup> has observed that from a mechanistic point of view these have not been very helpful. In the case of all the transition metals studied, it is necessary to consider any metal-ligand interaction as involving the lone pair electrons of the oxygen in the water molecules. Though there is considerable difference between the masses of the isotopes of hydrogen, the change of medium has at best a secondary small influence and for an ionic or ion-dipole reaction the small difference in dielectric constants can cause very little difference. This is actually found to be the case. The effect will be still smaller if hydrogen does not participate in the transition state. The absence of any perceptible effect of replacing water by D<sub>2</sub>O in the reaction between the aquo-complexes of Cr (II) and some pentammine Co (III) derivatives is a pointer in this direction.<sup>8</sup> Similarly the dipyriddy complexes of Cr (II) show even smaller effects with the pi-electron system of the aromatic system functioning as an electron screen for the electron transfer.<sup>9</sup> Replacement of NH<sub>3</sub> by ND<sub>3</sub> in the electron transfer process is noticed to lead to a small reduction in the rate.<sup>10</sup> This is quite understandable from the structure of the complexes involved and can be reconciled with the extensive work of Taube and his school.<sup>11</sup>

An aspect of isotope effects that does not appear to have been taken into account is the geometry of the complex, weak and strong field interactions between ligand and metal and

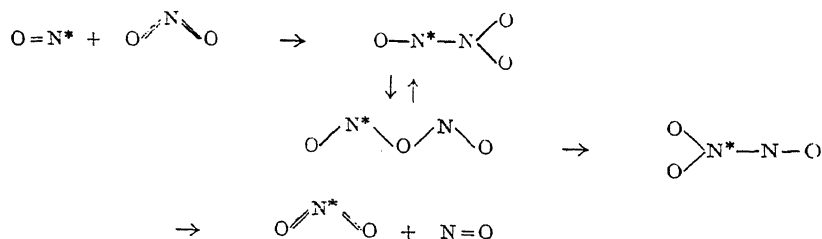
isotope effects negligible. Basolo and Pearson<sup>12</sup> remark that  $\Delta E_0$  is found to be zero even though for a reaction of the type



this should not be zero as small isotope effects may favour the heavier isotope in one or other state and, except for the lightest isotopes, may be neglected. This is only to confirm that isotope effects in such cases fail to give a lead in understanding the mechanism of the process. The entropy term which also is involved in the rate constant depends to some extent on guessing the geometry of the transition state which is not possible from isotope studies.

The limitations are shown even in the study of simpler molecules. In the oxidation-reduction of chlorate to chloride and perchlorate in the potassium salt, isotope effects can at best rule out a dissociative mechanism but no further progress is possible.<sup>13</sup> This difficulty is common to all similar reactions especially in the solid state. Another reaction where isotope effects are not of much use is shown by hydrogen peroxide. Bond rupture in the compound can lead to two labile intermediates OH and HO<sub>2</sub> either of which can continue the chain process of decomposition, whether one uses flash photolysis or other means. The reported failure of the use of isotopic oxygen in the reaction mechanism is not surprising. The use of isotopes can be justified only where there are distinct alternative paths for a reaction in which the nature of the bonds involved lead us to expect differences.

In the concentration of isotopes by using chemical reaction in isotopic exchange or by homogeneous catalysis, it is natural to look for possible mechanisms. For the simultaneous concentration of N<sup>15</sup> and O<sup>18</sup> by the NO<sub>2</sub>-NO reaction, Klein, Spindel and Stern<sup>13</sup> have suggested the following mechanism:

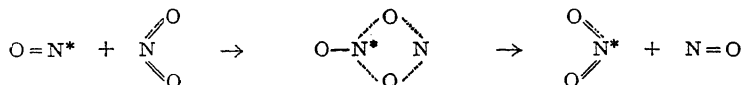


possible changes in substitution mechanisms. All these factors modify the activation energy for the reaction and an overall result can make

The reported activation energy for the reaction is of the same order of magnitude as the potential barrier to rotation about the N-N



axis in dinitrogen tetroxide. It is much easier to visualise a simpler mechanism which does not involve so many stages in which we can postulate a transient intermediate having a bridge structure analogous to what has been postulated for the dimer of  $\text{NO}_2^{14}$ .



Again we find that isotopic studies do not give the answer to the mechanism.

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## BIOLOGICAL EFFECTS OF NEUTRON IRRADIATIONS

M. S. SWAMINATHAN

Indian Agricultural Research Institute, New Delhi

A FIVE-DAY symposium on the biological effects of neutron irradiations, organized by the International Atomic Energy Agency, was held at the Brookhaven National Laboratory, U.S., beginning on October 7, 1963. Papers presented at the symposium related to topics such as neutron dosimetry, use of high energy protons, cellular and genetic effects, pathology, and the relative biological effectiveness of neutrons. Besides the contributed papers, there were also general addresses and invited survey papers.

### DOSIMETRY

Several papers on Neutron-dosimetry brought out the complex nature of the problem, the need for evolving an acceptable system of classification of neutron energies, and recent improvements in the accurate measurements of dosimetry. Dr. W. S. Snyder (U.S.) pointed out that the average linear energy transfer (LET) will not give a correct index of the dose delivered. Also, the LET distributions vary with the energy of the neutrons, e.g., 14 MeV neutrons differ in LET distribution from Fission neutrons. Dr. B. R. Banville (Canada) said that experience with the slow neutron facility

in NRX reactor at Chalk River has shown that dose determination is simple only if the volume of the sample is small. Samples which are over 1 cm.<sup>3</sup> in size present many problems. Dr. T. S. Mobley (U.S.) showed how through surgical techniques neutron doses can be ascertained in living tissues. A Russian group of scientists urged the need for more biological experiments using neutrons in the range of energy from a few KeV to 500 KeV. Dr. D. Hightower (U.S.) presented results of tissue activation analysis in neutron-irradiated dogs. This technique gives a good idea of the neutron penetration curve. The actual dose delivered to specific internal organs can be judged. During exposure P 32 and S 35 are produced in tissues and these can be traced in autoradiographs.

### RADIO-BIOLOGICAL DAMAGE

Prof. Y. I. Moskalev (USSR) compared the biological effects of fast neutrons and protons of high energy and showed that the RBE of neutrons is 3 in many cases. While working with animals there are differences in reaction depending upon whether spermatids or super-

matozoa are exposed. He pointed out further that RBE values change considerably depending upon the index used to measure the radio-sensitivity. Dr. Bond (Brookhaven) gave the following figures for RBE of fast neutrons in different animals: Mouse, Index LD-50/5 days, RBE 3; Rat, LD-50/30 days, RBE 2.8; Dog, Early death, RBE 2 to 2.5; Dog, LD-50/30 days, RBE 0.95.

Dr. Barendson (Netherlands) discussed macroscopic, microscopic and sub-microscopic dosimetry. The spatial distribution in ionization will influence biological effects. The target theory alone is inadequate to explain radiobiological damage. Dr. Fowler (U.K.) elaborated how the target theory helps to understand differences arising from variations in LET. Dr. Sparrow (U.S.) indicated how radiation-sensitivity can be predicted on the basis of nuclear volume. With increasing volume there is increasing RBE. He suggested that chromosome volume should be used as a measure to assess radiation-sensitivity. Dr. Tobias (U.S.) posed the question: "Are the differences between X-rays and neutrons in producing cell damage solely due to energetics, or are there differences in the mechanism through which cell death is brought about?" Dr. Tobias also gave evidence for inferring that the indirect action component of radiation effects may be quite considerable. Thus in *Neurospora*, irradiated adenine did some damage when introduced into the cell. Irradiated base analogues have an effect similar to that of direct irradiation.

#### CELLULAR AND GENETIC EFFECTS

Presenting data on the effect of mono-energetic neutron irradiation of human cells in tissue culture, Dr. J. J. Broerse (Netherlands) showed that the survival of cells was greater with 15 MeV than 3 MeV neutrons. Dr. Bender (U.S.) described the types of chromosome aberrations induced by neutrons in human cells. The RBE for fission neutrons is about 5 with regard to chromosome aberration. In peripheral leucocytes chromosome aberrations are seen even 20 years after an accident. The results presented by Dr. A. G. Searle (U.K.) suggest that neutrons at low intensity have the same RBE as gamma-rays and neutrons at high intensity have the same RBE as X-rays. In general, low intensity neutrons are efficient in

inducing mutations in mice. The mutations induced in mice are believed to be point mutations because changes occurred in only one of the genes among two closely linked loci.

#### NEUTRONS IN AGRICULTURE

There were several papers dealing with the use of neutrons for inducing mutations in crop plants. The entire situation was reviewed in a survey paper by Dr. A. R. Gopalayengar and Dr. M. S. Swaminathan (India). They pointed out that neutron irradiation will be particularly valuable in inducing mutations in polyploid plants. Dr. Gopalayengar and N. S. Rao (India) showed that the effects of thermal neutrons can be modified by the combined use of diethyl sulphate and neutrons. They stressed the importance of such combined treatments. Dr. Yamaguchi (Japan) described the effect of neutron irradiation in rice, and showed that different varieties of rice respond differently to irradiation. Dr. J. P. Miksche (Brookhaven) presenting the results of work under the Brookhaven Co-operative Mutation Programme gave a list of varieties that have been released in the United States as a result of mutation breeding, since 1953 (Table I).

TABLE I  
'Radiation-induced' varieties released in the  
United States since 1953

Mutation	Mutagen	Crop
1 Sanilac bean (Vine to erect type of growth, disease resistance)	X-ray	Pea bean Michilite variety
2 Seaway bean (Erect type of growth, virus resistance)	X-ray	Pea bean Michilite variety
3 Gratiote bean (better seed type)	X-ray	Pea bean Michilite variety
4 Florad oats (Disease resistance)	Thermal neutrons	Oat Floriland variety
5 Alamo $\times$ oats (Disease resistance)	X-ray	Oat Alamo variety
6 NC 4 $\times$ peanut (Tougher hull)	X-ray	NC 4
7 Pennrad barley (better winter hardiness)	Thermal neutrons	Barley Hudson variety
8 Yukon I carnation (less petals and holds longer)	X-ray	White Sim carnation

## LETTERS TO THE EDITOR

### ON THE DIFFUSION THEORY OF CONCENTRATION EXTINCTION OF FLUORESCENCE

SVESHINKOV AND TISHCHENKO<sup>1</sup> have reported that the concentration extinction of fluorescence of anthracene can be explained by the diffusion theory if one considers that in addition there exists a different kind of quenching which is caused by the fluctuation in the distribution of solute molecules in solution. This quenching is called statical extinction by them. In a previous communication,<sup>2</sup> we have discussed the problem of concentration quenching of fluorescence of eosine, acraflavin and rose bengal in glycerine. In order to study the problem of application of diffusion theory to concentration extinction, we have extended our measurements to the determination of the fluorescence yield with concentration in different solvents. The intensity of fluorescence in transverse direction in different solvents was measured in terms of the intensity of the incident light using a sensitive potentiometer balancing arrangement and photovoltaic cells.<sup>2</sup> The fluorescence yield was measured for rhodamin concentrations varying from  $2 \times 10^{-6}$  g./c.c. to  $2 \times 10^{-4}$  g./c.c. The solvents used are acetone, benzene, ether, ethyl alcohol and glycerine.

The dependence of fluorescence yield on the concentration of rhodamin is shown in Fig. 1. The dependence of yield on the viscosity of the solvent is shown in Fig. 2.

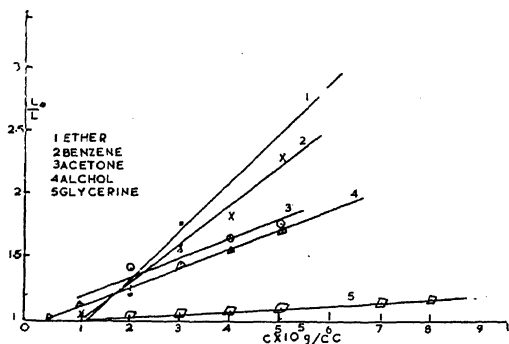


FIG. 1

According to the diffusion theory of extinction, when the concentration is small  $L_0/L$  is a linear function of  $C$  (concentration) and of  $1/\eta$  (viscosity), provided the kinetics sphere and the effective sphere of the collision of the second kind are not very different. Here  $L_0$  and  $L$  are the yield of fluorescence in the

unextinguished and extinguished solutions respectively.<sup>3,4</sup>

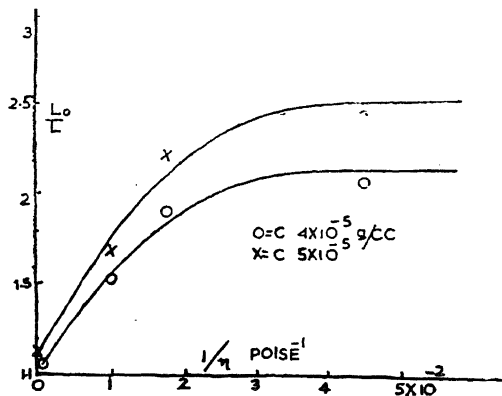


FIG. 2

In our measurements Fig. 1, the linear relationship between  $L_0/L$  and  $C$ , clearly shows the participation of diffusion process in the concentration extinction of fluorescence. However, in Fig. 2, a deviation from the linear relationship between  $L_0/L$  and  $1/\eta$  indicates that the diffusion theory is not adequate by itself and one must look for an additional process of concentration extinction. As our curves are similar to those obtained by Sveshnikov and Tishchenko<sup>1</sup> for the dependence of the fluorescence yield of anthracene on the viscosity of the solvent, it is not unreasonable to assume that the mechanism of concentration extinction of fluorescence of rhodamin is similar to that of anthracene. And hence in conclusion it may be said that the variation of the fluorescence yield with concentration of rhodamin and the viscosity of the solvent, cannot be explained only by considering the extinction due to diffusion process and it is necessary to consider, in addition, the static extinction.

Department of Physics, M. K. MACHWE,\*  
University of Delhi, JUGAL KISHORE.  
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K. D. CHAUDHURI.

\* Present address: Postgraduate Department of Physics, Jammu and Kashmir University, Srinagar.

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# DYE SENSITIZED POLYMERIZATION OF VINYL MONOMERS IN AQUEOUS SOLUTION

**MECHANISM** of polymerization of vinyl monomers in the visible light by dyes<sup>1-7</sup> and dye-reducing agent<sup>8-10</sup> in aqueous solution has been explained as conforming to one of the three types: (i) energy transference between the excited dye and monomer,<sup>1</sup> (ii) production of radicals as a result of interaction of excited dye molecule and monomer<sup>2-3,5,7</sup> and (iii) production of radicals by self-decomposition of the dye<sup>6</sup> or by interaction of excited dye with a third substance like oxygen or OH<sup>-</sup> or the reducing agent.<sup>4,8-10</sup> As an example of the last type the work of Delzenne and his co-workers<sup>10</sup> who have proposed formation of radicals from hydrogen peroxide (formed during the reoxidation of leuco derivative or semi-quinone dye by molecular oxygen) is significant. Conflicting views have therefore been expressed with regard to not only the mechanism but also the necessity or otherwise of oxygen and/or reducing agent in the system for polymerization to occur.

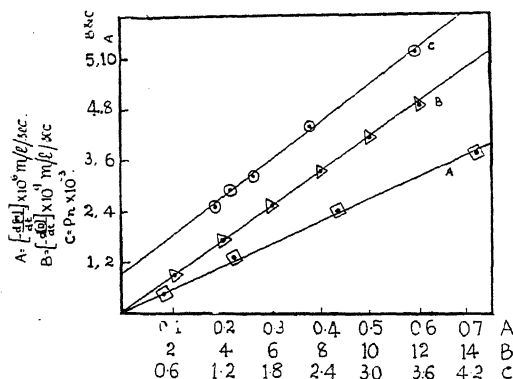


FIG. 1. A,  $[M] \times 10^2$  ( $m/l$ ); B,  $[Sodium\ Fluorescein] \times 10^6$  ( $m/l$ ); C,  $[Ascorbic\ acid] \times 10^{-2}$  ( $m/l$ ), at  $35^\circ C$ .  $\lambda = 4350 \text{ \AA}$ .

We have used sodium salt of fluorescein-ascorbic acid (reducing agent)-molecular oxygen, buffered (pH 6 to 8) for polymerization of methyl methacrylate at  $35^\circ C$ . The wavelengths 365 m $\mu$ , 405 m $\mu$  and 435 m $\mu$  were found to be effective. A number of preliminary experiments have been carried out with the systems: (a) Monomer-reducing agent, (b) monomer-dye, (c) monomer-dye-reducing agent under diverse conditions: presence of oxygen or deaerated; diffused daylight or at wavelengths 365 m $\mu$ , 405 m $\mu$ , and 435 m $\mu$ ; buffered with phos-

phate or phthalate or sodium hydroxide for different pH's (4 to 8). The course of polymerization was followed by determining the rates of monomer disappearance (gravimetrically); dye disappearance (spectrophotometrically) using  $\lambda = 4840 \text{ \AA}$ . the maximum for the dye) and the chainlengths of polymethyl methacrylate (viscometrically). It has been found that the rate of disappearance of monomer is directly proportional to one-half powers of light intensity, light absorption fraction by the dye and concentration of reducing agent and second power of monomer concentration (Fig. 1, A). The rate of dye disappearance has been found to be proportional to first powers of light intensity, dye concentration (Fig. 1, B), reducing agent and monomer concentration. Chainlengths are inversely proportional to one-half powers of light intensity and reducing agent concentration (Fig. 1, C) and directly proportional to second power of monomer concentration. Apart from this systematic investigation, we have made the following observations not reported so far: (i) Ascorbic acid alone buffered at pH 4 to 8 initiates polymerization under deaerated conditions without induction period; in the presence of oxygen there is induction period but rate of polymerization is slightly higher than in the deaerated system; (ii) there is no initiation with this dye alone or dye-buffer system; (iii) dye-ascorbic acid-phosphate buffer-oxygen system appears to be the most effective; (iv) with the buffers the order of efficacy is phosphate, phthalate > sodium hydroxide; and (v) with phosphate the rate increases with decrease of pH. Most of our observations may be explained by assuming the transference of energy from the excited dye molecule to reducing agent-buffer complex in the presence of oxygen leading to radicals which initiate polymerization accompanied by usual propagation step and mutual termination of growing free radicals. A detailed paper with kinetic results and discussion will appear elsewhere.

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#### A NEW EXAMINATION OF THE SPECIAL COMPONENTS OF *PTEROCARPUS INDICUS* HEARTWOOD

NARRAWOOD or *Pterocarpus indicus* is indigenous to Malayan peninsula and particularly Philippines. Brooks<sup>1</sup> investigated the special chemical components of its heartwood as early as 1910 and reported the presence of a colouring matter called narin and of two colourless components, pterocarpin and homopterocarpin. More recently, Gupta and Seshadri<sup>2</sup> examined two samples, one obtained from Kepong, Malaya, and the other from Philippines and identified only angolensin being present in an yield of 0.1%; pterocarpin and homopterocarpin were found to be absent. With a view to isolate angolensin for another study, we procured some narrawood from Philippines. In the course of this study, some new results have been obtained. Though our programme is still incomplete, a brief report is now made in view of the recent publication of Cooke and Rae.<sup>3</sup>

Two samples, one more coloured than the other, were extracted successively with light petroleum (b.p. 60–80°), ether and ethanol. Light petroleum extract of the more coloured sample yielded as solids homopterocarpin (m.p. 86–87°) in a high yield (ca. 1.3%) and a steam volatile fraction (m.p. 80–81°; 0.5%) which appears to be terpenoid in nature. From the ether extract after concentration and cooling an amorphous coloured material separated out. The mother liquor was found to contain small amounts of formononetin (m.p. 250–252°) as the sodium carbonate soluble part and homopterocarpin as the neutral fraction. Ethanol extract gave more of homopterocarpin and formononetin. Total yields from 550 g. of the heartwood were homopterocarpin 9.5 g., steam volatile component 3 g. and formononetin 160 mg.

The light petroleum extract of the less coloured sample was found to contain lesser amounts of homopterocarpin and the steam volatile fraction and also a little amount of pterocarpin (m.p. 162–63°). Ether extract gave the same components as in the case of the more coloured sample; whereas ethanolic extract yielded more of pterocarpin besides homopterocarpin and formononetin. Total yields from 450 g. of the heartwood were homopterocarpin 4.4 g., steam volatile compound 1 g., formononetin 20 mg. and pterocarpin 60 mg.

Angolensin was originally considered to be rare in its occurrence.<sup>4</sup> But now it has been found in a number of *P. species*.<sup>2,5</sup> Formononetin has not so far been found in *P. species*; our results agree with those of Cooke and Rae<sup>3</sup> in recording its presence in *P. indicus*. Similarly it is interesting to note that isoliquiritigenin which was earlier found in three *P. species* (*P. dalbergioides*, *P. santalinus* and *P. macrocarpus*)<sup>6</sup> is found also in *P. indicus*.<sup>3</sup> Surprisingly angolensin is absent in the samples now examined. In this respect and in having homopterocarpin in large amount, these wood samples differ markedly from those examined earlier by Gupta and Seshadri<sup>2</sup> and recently by Cooke and Rae.<sup>3</sup> The latter group of workers have extracted 100 pounds of the wood and isolated angolensin (174 g.), pterocarpin (13.2 g.), pterofuran (0.5 g.), formononetin (3.1 g.), isoliquiritigenin (0.5 g.) and (–) *p*-hydroxyhydratropic acid (70 mg.). This difference in the results suggests that there can be a large variation in the special components of even the same heartwood. Probably these different compounds represent different stages of evolution because they are all interrelated in the scheme of biogenesis. An examination of other samples of narrawood is in hand and the full results of these combined investigations will soon be published.

Department of Chemistry,  
University of Delhi,  
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A. C. JAIN.  
T. R. SESHADRI.

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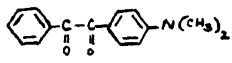
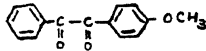
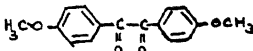
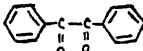
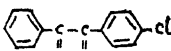
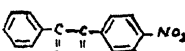
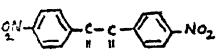
### CARBONYL FREQUENCIES IN SOME SUBSTITUTED BENZILS

BENZIL is reported to have a skew configuration in which the two carbonyl groups are not in the same plane making an angle of  $90^\circ$ – $100^\circ$  with each other by a study of the spectroscopic,<sup>1</sup> dipole moment<sup>2</sup> and X-ray diffraction measurements.<sup>3</sup> In such a case, there can be little or no conjugation between them and each carbonyl group should therefore behave quite independent of the other. In benzil and symmetrically substituted benzils, the environment of the two carbonyls is the same and therefore only one  $>C=O$  band should result. But in the case of unsymmetrical benzils containing a substituent in *p*-position of one of the phenyl rings, the two  $>C=O$  groups are not identical in the sense that one is attached to phenyl and the other to substituted phenyl group. Hence two  $>C=O$  bands should appear, one corresponding to the benzoyl carbonyl, the same as that in benzil, and the other pertaining to the substituted benzoyl carbonyl.

With this object in view, the infra-red spectra of benzil, 4:4'-dimethoxy, 4:4'-dinitro 4-methoxy, 4-dimethylamino, 4-chloro and 4-nitro benzils have been recorded in  $CHCl_3$  solution because of poor solubility in  $CCl_4$ . The  $>C=O$  frequencies are given in Table I.

TABLE I

$>C=O$  stretch frequencies in the I.R. spectra of symmetrical and unsymmetrical benzils in  $CHCl_3$  solution

Compound	$>C=O$ stretch frequencies cm. <sup>-1</sup>	
	1677	1661
	1677	1671
	..	1671
	1677	..
	1677	1689
	1677	1691
	..	1691

The data reveal that the symmetrical benzils give only one  $>C=O$  band. The  $>C=O$  frequency of benzil is close to that of acetophenone in agreement with the report of the earlier workers.<sup>4,5</sup> The  $>C=O$  frequencies of 4:4'-dinitro and 4:4'-dimethoxy benzils are close to those of *p*-nitro acetophenone and *p*-methoxy acetophenone respectively. Unsymmetrical benzils, on the other hand, gave two bands as expected. One of them had the same frequency as that of benzil and the other appeared at a higher frequency when  $NO_2$  and  $Cl$  groups were present in the *p*-position of one of the phenyl rings and appeared at a lower frequency when methoxyl and dimethylamino groups were present in the same position. This goes to prove that the difference in environment of the two carbonyl groups is responsible for splitting of the  $>C=O$  band, and that the two carbonyls are not in the same plane as they are acting independent of each other. It may be mentioned in this connection that similar conclusions regarding the non-planarity of the carbonyl groups in symmetrical benzils have been drawn by Leonard and co-workers<sup>6-8</sup> from the study of ultra-violet absorption spectra.

The findings in this paper, in addition, indicate that electron attracting groups like  $NO_2$  enhance the  $>C=O$  frequency and electron releasing groups like  $-OCH_3$  and  $-N(CH_3)_2$  lower it.

While this paper was under preparation, a paper published by Bernal<sup>9</sup> reporting a splitting in the  $>C=O$  band of benzil has come to our notice. This result is at variance with the earlier observations and therefore requires further scrutiny.

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Osmania University, A. MURALIKRISHNA.  
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THE ORIGIN OF THE INCREASED  
NAD GLYCOHYDROLASE ACTIVITY  
IN EXPERIMENTAL TUBERCULOSIS

We have reported the presence of the enzyme NAD glycohydrolase in an inhibited state in the crude cell-free extracts of the organism *Mycobacterium tuberculosis* H37 Rv, grown *in vitro* and its activation and purification from that source.<sup>1,2</sup> The presence of this enzyme in an active state in the lung-grown tubercle bacilli and an increase in this enzyme activity in the tuberculous infected mouse tissues have been reported by other workers.<sup>3,4</sup> Our interest was to trace the origin of this increased NAD glycohydrolase activity in infection, that is, whether this increased activity is due to the activation of the bacterial enzyme on growth *in vivo* or it is of the host origin as observed in the other cellular degenerative processes.<sup>5,6</sup>

In this communication, we have given evidence of the host origin of the increased NAD glycohydrolase activity in tuberculous infection and also of the actual existence of one of the postulated modes of action of the potent anti-tubercular drug, isonicotinic acid hydrazide (INH), *viz.*, the formation of the INH analogue of NAD.<sup>7,9</sup>

The NAD glycohydrolase and the NAD-INH exchange activities of the normal and tuberculous mouse tissue homogenates were determined by the methods reported earlier.<sup>2,7</sup> The specific activities of the preparations are given in Table I.

inhibitor preparation (unpublished). These results clearly establish that the NAD glycohydrolase activity in infection had the same properties of the host enzyme and differ from the bacterial enzyme considerably.

In addition, as shown in Table I, the NAD-INH exchange reaction also is increased concomitantly in tuberculous infection and the INH analogue of NAD has been isolated and characterized. The formation of such an analogue is one of the postulated modes of action of this potent antitubercular drug. This is the first communication wherein the actual demonstration of the NAD-INH exchange reaction is reported in tuberculous infection and might account well for the above mode of action of the drug *in vivo*.

Another interesting finding was the participation of NMN and NADP also, in the NAD glycohydrolase catalyzed exchange reaction by normal, as well as infected mouse tissue enzymes, at varying rates.

The detailed paper will be published elsewhere.

Pharmacology Lab. and K. P. GOPINATHAN.  
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TABLE I

NAD glycohydrolase and NAD-INH exchange activities of normal and tuberculous mouse tissue extracts

Source of enzyme	NAD glycohydrolase			NAD-INH exchange		
	Specific activity ( $\mu$ m-moles of NAD per min. per mg. protein)		Per cent. increase over the normal	Specific activity ( $\mu$ m-moles of INH-analogue of NAD formed) per min. per mg. protein		Per cent. increase over the normal
	Normal	Infected		Normal	Infected	
Lung	9.55	16.26	70	3.33	4.99	50
Liver	5.89	7.94	35	2.02	2.39	18

The enzyme from *M. tuberculosis* did not catalyze the analogue formation between NAD and INH.

The properties of the NAD glycohydrolase from lungs of normal and infected animals were compared with that of the purified bacterial enzyme,<sup>2</sup> which include the pH optima, substrate specificity, Km values, sensitivity to chemical inhibitors and the specific bacterial

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# A HEAT-PROCESSING METHOD FOR THE ENRICHMENT OF WHITE RICE

A METHOD of heat treatment under closed conditions for quick artificial ageing of fresh milled rice has been recently described by us.<sup>1</sup> The same method has now been found to lend itself to the enrichment of white rice with vitamins and minerals by merely mixing the nutrients with the rice prior to its heating.

The method essentially consists in adding the nutrients in powdered form on to the rice (10-40 kg. batches) taken in a jacketed closed rotating drum, heating the contents till the rice attains a temperature of 90-95° C. and then storing it overnight under insulation so as to permit slow cooling. Enrichment with calcium as also with thiamine, nicotinic acid and riboflavin were tried. The nutrients were generally added in the following proportion: Calcium (usually as carbonate), 100 mg.; thiamine hydrochloride, 400 µg.; riboflavin, 400 µg. and nicotinic acid, 4 mg. per 100 g. of rice. The vitamins were added mixed either with the calcium carbonate or, if used alone, with powdered r.i.e. The extent of loss of the nutrients on washing was determined by the following washing test: Twenty-five grammes of rice and 60 ml. of water were swirled 15 times in a 250-ml. Erlenmeyer flask, and the supernatant, along with the floating particles, decanted; this was repeated two more times. This represented, in terms of household practice, a quite exhaustive washing. The washed rice and the original rice were then analysed for the required nutrients. Calcium was estimated by oxalate precipitation,<sup>2</sup> thiamine by the thiochrome method,<sup>3</sup> nicotinic acid with cyanogen bromide and metol<sup>4</sup> and riboflavin fluorometrically.<sup>5</sup>

Typical data for washing loss of nutrients in some batches of rice are presented in Table I. Barring riboflavin, retention of the other nutrients, particularly calcium and thiamine, in the enriched rice was evidently satisfactory. The heat treatment thus in some way caused these nutrients to get relatively fixed on to the rice. This effect of the heat treatment is more strikingly shown in the case of unenriched rice. Whereas untreated rice lost a very large proportion of its contents of thiamine and nicotinic acid on washing, this loss was reduced very considerably after the heat treatment. Incidentally, these results also show that the heat treatment *per se* had no deleterious effect on the natural thiamine content of rice; also, inclusion of calcium carbonate did not affect

either the incorporation or retention of the added vitamins.

TABLE I

Retention of nutrients by untreated, heat-treated enriched rice after washing

A freshly-harvested *Bangar Samrat* variety of rice was used

Rice	Nutrient		
	In original rice (mg. %)	In washed rice (mg. %)	Retention (%)
Calcium			
Untreated	12	..	..
Ca-enriched	101	74	73
Ca + Vit*-enriched	109	81	74
Thiamine			
Untreated	0.170	0.065	38
Heat treated	0.180	0.160	89
Vit-enriched	0.450	0.315	70
Ca + Vit-enriched	0.490	0.365	74
Nicotinic acid			
Untreated	1.90	0.55	29
Heat treated	1.92	1.35	70
Vit-enriched	5.41	3.38	62
Ca + Vit-enriched	5.22	3.09	59
	(5.99)†	(4.24)	(71)
Riboflavin			
Untreated	0.040	0.015	38
Vit-enriched	0.346	0.132	38
Ca + Vit-enriched	0.371	0.149	40
	(0.337)	(0.157)	(47)

\* Vit indicates thiamine, nicotinic acid and riboflavin.

† Figures in parentheses represent results of an experiment in which the rice, in the enrichment process, was subjected to a longer period of heating than usual (60 min. in place of about 40).

The importance of the nutritional enrichment of raw milled rice is now well recognised.<sup>6,7</sup> Rice has been enriched so far primarily by a method of coating a solution of vitamins and iron around the grains in a 'premix' followed by a further protective coating of an edible film.<sup>8</sup> The present method dispenses with the use of solutions and has the advantage of enabling the fortification of rice with calcium as well, in which mineral it is particularly deficient. Retention of riboflavin in this method is not yet satisfactory, but this is being further studied.

I wish to thank Drs. H. S. R. Desikachar, V. Subrahmanyam and M. Srinivasan for their valuable advice and encouragement.

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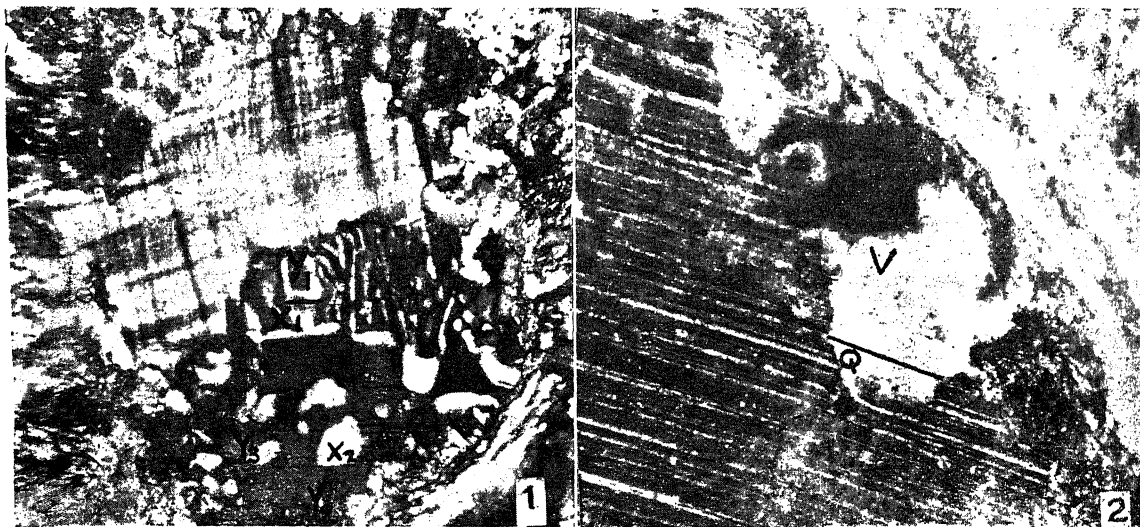
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# DIFFUSION THROUGH PLAGIOCLASE FELDSPARS AND ITS BEARING ON MYRMEKITE FORMATION

MUCH controversy exists regarding the origin of myrmekite in granitic rocks. While Becker<sup>1</sup> and Tilley<sup>2</sup> supported the view that myrmekite is due to the replacement of potash feldspar by plagioclase, Reynolds<sup>3</sup> and Drescher-Kaden<sup>4</sup> thought it to be due to the replacement of plagioclase by K-feldspar. Recently, Sarma and Raja<sup>5</sup> have suggested that myrmekite is due to the breakdown of the anorthite component of plagioclase, expulsion of Ca and Al, leaving behind quartz in relatively acidified plagioclase.

In this note an attempt is made to present some of the studies made on the myrmekites from the granitic rocks east of Khammam, Andhra Pradesh (long. 80° 19', lat. 17° 24'). The feldspars are coarse-grained, grey or light pink in colour and include both plagioclase (An<sub>20-25</sub>) and potash feldspar which is often microcline. They are frequently somewhat porphyroblastic and present corroded outlines towards the groundmass which consists chiefly of quartz and biolite. Both myrmekites and perthites are fairly common.

The development of myrmekite in the rocks seems to be a metasomatic phenomenon. For instance, in Fig. 1, the formation of myrmekite can be partly traced. The arrangement of quartz blebs and vermicules appear to suggest a lattice control by the plagioclase, i.e., one set of quartz tubules are parallel to the plagioclase twinning (as at point X<sub>1</sub>); there is another set which is perpendicular and appears to be nearly parallel to the other set of plagioclase twins (poorly expressed as at Y<sub>3</sub>, Y<sub>2</sub>). The myrmekite may have formed by the introduction of silica initially along the plagioclase twin-lamellae and subsequently by further encroachment. In some of the large quartz areas (between X<sub>1</sub> and Y<sub>1</sub> in Fig. 1) the plagioclase twinning continues undisturbed. Similarly in Fig. 2 (which is not a myrmekite but could be a stage in its formation, and is similar to 'southern' part of myrmekite of Fig. 1) islands of quartz are slowly encroaching on plagioclase. They present very irregular, diffuse and gradational boundaries to the plagioclase host. Within the quartz areas the plagioclase twinning still continues undisturbed faintly (as at the point Q). This feature suggests that the silica (possibly from the groundmass) diffused into the plagioclase without in any way breaking down the lattice of feldspar. At the point V there appears to be a slight disordering in the lattice (seen by the shifting of the twin-lamellae). Such features have been applied by the senior author<sup>6</sup> in tracing mineral paragenesis of the rocks of New Jersey Highlands, U.S.A.



FIGS. 1-2

From these studies a number of conclusions are drawn tentatively: (1) The plagioclase of myrmekite is earlier formed and quartz is later. (2) This quartz is not of endogene origin but introduced from outside, possibly from the ground mass. This is suggested by (a) the slight disturbance of twin-lamellæ at the margin of plagioclase (at the point V in Fig. 2) and (b) the presence of a sort of small-scale basic front near the same point V in Fig. 2 which could have been formed only by the removal of silica from the ground-mass. (3) The diffusion of silica initially may have been through intergranular spaces but subsequently through the lattice of plagioclase. The lack of disordering in the plagioclase lattice may be more consistent with dry ionic diffusion than bodily migration of solutions which was suggested by Drescher-Kaden.<sup>4</sup> (4) The authors do not agree with the views of Sarma and Raja<sup>5</sup> that the myrmekite is formed by the breakdown of the anorthite component of plagioclase under stress. The reasons are that the myrmekitic plagioclase is not more acidic than the rest of the plagioclase; secondly there is no epidote, apatite, etc., in the immediate neighbourhood which should have formed by the expulsion of Ca and Al from the anorthite component; thirdly if the anorthitic part of the original plagioclase were to break up under stress the released quartz present as tubules in the myrmekite may be expected to be optically continuous (especially when the associated plagioclase is optically continuous). Such is not the case in all the quartz vermicules of myrmekites examined by the authors. This suggests that the silica is exogene and introduced later.

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Geology Department, Y. JANARDAN RAO.  
Osmania University, CH. SUDARSANA RAJU.  
Hyderabad-7, December 5, 1963.

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#### USE OF OIL IMMERSION OBJECTIVE IN THE DETERMINATION OF REFRACTIVE INDEX OF MINERAL FRAGMENTS BY IMMERSION METHOD

DETERMINATION of refractive indices of minerals by immersion method is a routine procedure in most mineralogical laboratories. However the chief problem of the procedure is the refinement of the technique of picking out a very small mineral grain (that has in often cases passed through a hundred mesh sieve) and embedding it in a liquid. This technique is a little cumbersome and time-consuming demanding steadiness of the operator's hand. It is suggested that the oil immersion objective effectively solves this problem making the work quite fast and pleasant.

In his laboratory, the writer uses 10 X objective and 100 X oil immersion objective with a Leitz microscope. Before the start of the work, accurate centring of both the objectives is necessary. After searching a suitable grain from a mineral spread on glass slide with 10 X objective, it is much easier and quicker to brush aside the other surrounding grains with a pointer drawn out of a glass rod than to pick up the particular grain and transfer it to another slide. Even if a few grains closely situated to the grain under examination are left in position, further work is not hampered and on the other hand these may be used for comparison during refractive index determination. However at the beginning care may be taken to scatter the minerals spread on the slide.

After bringing the required grain at the intersection of the cross-wires, the 10 X objective is removed and the oil immersion objective with a drop of liquid applied to its lens is inserted. The final contact between the liquid drop and the mineral grain is achieved by the fine adjustment of the microscope. Further work is carried out again by inserting the 10 X objective.

It has been found that the mineral grains are generally never displaced or crushed and about three grains at a time can get nicely embedded in the liquid drop placed in this fashion.

Subsequent liquids can be applied in a similar way after evaporating earlier liquid by gently warming the slide on a hot plate.

The time required to embed the grain in a liquid after its selection is about five minutes. This method can be particularly used by those seeking to investigate simple mineral grains. The chief advantage of the oil immersion objective in this procedure is its mechanicalness that can be taken advantage of even by a beginner in refractive index determinations.

The writer is grateful to Professor C. E. Tilley, F.R.S., of the Cambridge University, England, for reading the note.

Geology Department, M. G. PAITHANKAR.  
Government Science College,  
Jabalpur, September 16, 1963.

#### GRANITE-PAKHAL RELATIONSHIP (YELLANDLAPAD AREA)

THE Pakhal belt of sedimentaries consists of conglomerate, gritty sandstone, slate, phyllite, limestone and quartzite and extends due north-west from Yellandlapad (Singareni Collieries) in the Godavari valley. They are structurally disturbed at the south-eastern end of the belt and surround here three exposures of granite gneisses, namely the Karepalli bay, the Yellandlapad bay and the Bethampudi bay. The stratigraphic position of the Pakhals relative to the granite gneisses has been a subject of controversy.

According to King,<sup>1</sup> who first described the geology of the area, the Pakhals overlies unconformably the granite gneisses. Mahadevan<sup>2</sup> considered the Pakhals to be intruded by the granite in the Singareni area and hybrid rocks are formed at the contact. Heron<sup>3</sup> held the view that conglomerate occurs at the granite-Pakhal junction all along the Muneru river. Janardan Rao<sup>4</sup> considered the granite of the Yellandlapad area to be younger than the Pakhals and as derived by granitisation of the latter. According to Sarma and Appavadhanulu<sup>5</sup> and Raychaudhuri,<sup>6</sup> the granite-Pakhal contact is depositional all along the south-eastern margin of the belt.

Recent studies by the author have shown that the Pakhals overlies unconformably the granite gneisses and also a sequence of metasedimentaries which consist of quartzite, phyllite, talc-chlorite-, biotite schists, limestone, grunerite gneiss and ferruginous quartzite. The metasedimentaries occur as two narrow strips one in the

neighbourhood of Singareni village and the other near Mulakalapalli and may be described as 'Singareni strip' and 'Mulakalapalli strip' respectively. These metasedimentaries were previously thought to be part of the Pakhals presumably because of their superficial resemblance in lithology with the latter. The Mulakalapalli strip has been recognised independently by Raychaudhuri. The author proposes that the metasedimentaries of the two strips referred to be designated as 'Singareni Series'.

The basal conglomerate of the Pakhals overlies unconformably either the granite or the Singareni series of metasedimentaries and is well exposed at following places:

1. Conglomerate made up of pebbles of quartz, fragments of feldspar and angular pieces of phyllite and mica schist embedded in a shaly matrix, and gritty sandstone are noticed a mile south-east of Nizampet and two miles north-east of Pirpalle over the Karepalli bay granite.

2. Gritty sandstone and arkose frequently sheared occur a furlong north of Manditog and a furlong south-east and south-west of Puballi, over the Yellandlapad bay granite.

3. 'Singareni strip' of the metasedimentaries is overlain by conglomerate consisting of quartz, and ferruginous quartzite pebbles in a ferruginous matrix two furlongs west of Karepalli-Yellandlapad railway line, between 273 and 274 mile posts.

4. A basal conglomerate overlies the 'Mulakalapalli strip' of the metasedimentaries and is well exposed in the neighbourhood of Mulakalapalli village, and at the foot of the hill '1217'.

The studies show that the granite-Pakhal relationship in the Yellandlapad area is depositional marked by a conglomerate bed. On the other hand, granite shows intrusive relationship to the Singareni series exposed in the neighbourhood of the hill  $\Delta$  980', three furlongs north-east of Singareni village and two furlongs south-west of Bethampudi village. Within the Yellandlapad bay enclaves of phyllite with talcose material, biotite schists, ferruginous quartzites, etc., similar to the Singareni series occur in the granite.

The author wishes to place on record his grateful thanks to the late Professor C. Mahadevan under whose general guidance the work was carried out.

Geology Department, T. RAMAMOHA NA RAO.  
Andhra University,  
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#### REGENERATION OF OPERCULUM IN *POTAMIDES CINGULATUS* (GMELIN) (GASTROPODA: PROSOBRANCHIA)

REGENERATION of lost parts, which is a widespread phenomenon in the animal kingdom, has not been much studied in Mollusca. Cook<sup>1</sup> summarised some of the interesting features of Molluscan regeneration. When deprived of their tentacles, eyes, or portions of the foot, Mollusca do not suffer severely and can reproduce the lost parts in a short time. Some marine forms like *Harpa* and *Solen* are capable of some kind of autonomy. The regeneration of shell in several forms is fairly well known. But there do not seem to have been any observations on the regeneration of the operculum which is characteristic of Prosobranch gastropods and is formed by the posterodorsal region of the foot. The present account is a preliminary report of the author's studies on the regeneration of operculum in *Potamides cingulatus* (Gmelin).

The operculum of *Potamides cingulatus* is only slightly calcified, constituting mostly of conchiolin (about 99%). In the present study the operculum was completely removed from the foot with a sterilised scalpel. The animal was allowed to retract into the shell, and the mouth of the shell was plugged with sterilized cotton. The animals thus treated were kept for two days in water from the estuary, which is the normal habitat of the species. Two days later, the specimens were transferred into an aquarium containing mud at the bottom.

The normal operculum of *Potamides cingulatus* is about 4 mm. in diameter. The growth in diameter of the operculum during regeneration is shown below.

Time after removal of operculum	Diameter
3rd day	1 mm.
7th day	2.5 mm.
15th day	4 mm.

In fifteen days the operculum is regenerated to the normal size. The regenerating operculum is oval in shape to start with and as it develops,

attains a more rounded shape. It is also translucent, being composed at first of only a uniform layer of conchiolin. The normal operculum is opaque and showed concentric layers of conchiolin.

The regeneration of operculum is interesting in another way. It has to grow and fit into the size of the mouth of the shell. Normally the shell opening and operculum grow together and are mutually accommodated in growth. In the regeneration of operculum we have the interesting problem of its growth into the pattern set by the shell opening.

My thanks are due to Prof. R. V. Seshaiya, for suggesting the problem and encouragement. I am also thankful to the Government of India for the award of a Senior Research Training Scholarship.

U.G.C. Centre for Marine Biology,  
Porto Novo, S. India, December, 22, 1963.

T. N. C. RAMAPRASAD.

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#### PRELIMINARY OBSERVATIONS ON THE SUCCESSFUL INDUCEMENT OF BREEDING OF *CATLA CATLA* (HAMILTON)

As a measure of improving fish production in the Tungabhadra reservoir the necessity to introduce quick-growing species of Gangetic carps, which grow to large sizes, was recognised as early as 1959. With this end in view, large numbers of fry of Gangetic carps are being imported from Bengal annually, at considerable expense, and to date a total of 2.1 million fry have been stocked in the reservoir. To obviate the necessity of importing large quantities of fry and incurring of expenditure in the stocking programme, experiments on the inducement of breeding of Gangetic carps by the administration of injections of pituitary extracts were taken up and a notable measure of success achieved in the breeding of *Catla catla* is reported in this account.

The major Indian Gangetic carps, *Catla catla*, *Labeo rohita* and *Cirrhina mrigala* have been successfully bred by the administration of pituitary extracts (Anon., 1960; Chaudhuri, 1960; Alikunhi et al., 1960). Subsequent to these initial successes several attempts have been made in different parts of the country, with varying degrees of success to induce breeding

in the three species of carps (Mammen and Sulochanan, 1962). However, a significant fact that has repeatedly been observed in these experiments is that the percentage of successful inducements in the fastest growing species, viz., *Catla catla*, has consistently been low. Chaudhuri (1960) and Alikunhi *et al.* (1960) have attributed the low percentage of success in experiments with *Catla catla* to the unripe condition of gonads, incomplete ovulation or fertilisation and also accumulation of fat in the body cavity due probably to the fact of the breeders having been fed with fat-rich oil-cakes.

Taking these facts into consideration and based on the observation of several specimens which failed to respond to pituitary injections, Dr. B. S. Bhimachar (personal communication) postulated that the large percentage of failures in *Catla* could probably be attributable to the inhibitive action of the excessive fat deposits in the body cavity. Presumably, in nature, the pre-spawning migrations and the concomitant energy demands tend to reduce the fat accumulations in the body. In the present series of experiments, to subject the above view to experimental trials, the breeders have been fed on a diet of rice-bran only which has much lower fat content than oil-cakes, for two months prior to the experiment. It may be mentioned that in most of the earlier experiments by other workers the fish were fed on fat-rich oil-cakes. Postmortem examination of a few individuals that died during these experiments has indicated that the fat deposits around the alimentary tract and gonads in these rice-bran-fed fish were indeed very low.

Experimental trials in the present instance were conducted with fifteen sets of *Catla* (each set consisting of two males and one female) in cement cisterns provided with circulating water by the provision of inlet and outlet pipes. The fish ranged in total length from 500 to 630 mm. and in weight from 2½ to 3½ kg. Individual dosages of pituitary extracts were determined on the basis of the stage of gonadal maturity as deduced by external inspection and exudation of ova or milt on pressure. The donor species for the pituitary glands used in the experiments were Rohu, Mrigal and Mirror and Scale Carps from the Bellandur tank at Bangalore. Since it was observed in earlier experiments that subsequent to administration of the injection, the males tend to release milt much earlier than the females shed ova, the females were first given a provocative dose of

0.5 ml. of pituitary extract. Both males and females were then given effective doses of 0.5 ml. and 0.8 ml. respectively of pituitary extracts after an interval of six to seven hours.

The experiments were undertaken when there were heavy rains, during the period of 10th June to 4th July, 1963. Table I gives the details of experiments and the results achieved. The first trial was made with 3 sets of breeders in hapas fixed in a nursery pond. All other trials were conducted in cement cisterns. Water temperature in cement cisterns ranged between 26° C. and 26.5° C. and that in the nursery pond 25.7° C. and 26.0° C.

TABLE I

Date	Species	N. of sets	Estimated No. of eggs exuded	% fertilised	Hatchlings
10-6-1963	Catla	3	3,00,000	30	300
27-6-1963	"	1	82,000	50	500
1-7-1963	"	1	3,95,160	80	2,00,000
3-7-1963	"	1	4,00,000	70	2,50,000
4-7-1963	"	1	3,40,000	70	2,00,000

As can be seen from Table I the rate of fertilisation and ultimate survival up to hatching was very poor in the first set of experiments conducted in the nursery pond. This could probably be attributed to lack of sufficiently oxygenated, flowing water and tearing off of hapas by crabs and resultant loss of eggs. Two sets of breeders were used in the second series of experiments conducted on the 26th June. The females had to be injected thrice before they responded. In the third series three sets, out of the four injected, spawned successfully between 1st July and 5th July. The males were in a milting state and females in an advanced stage of maturity. The females bred after an initial provocative and second effective dose only. The most effective response and high rate of fertilisation and hatching was achieved in the experiments conducted in early July. None of the sets experimented upon after 8th July responded to the injections.

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Tungabhadra Board Fisheries, V. C. BADAMI.  
Tungabhadra Dam P.O.,

Mysore State,  
and

Lacustrine Unit of the Central A. DAVID.

Inland Fisheries Res. Inst.,  
Tungabhadra Dam P.O.,

Mysore State,

March 19, 1964.

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**PYRENOCHAETA ORYZAE SHIRAI**  
**ex-MIYAKE=ON ORYZA SATIVA L.—A**  
**NEW RECORD FOR INDIA**

SHIRAI AND MIYAKE<sup>5</sup> first reported *Pyrenochaeta oryzae* on paddy from Japan in 1910. Subsequently Butler<sup>1</sup> reported it from Burma in 1913; Wei<sup>8</sup> from China in 1934; Thompson<sup>6</sup> from Malaya in 1940 and Padwick<sup>3</sup> from Ceylon in 1950. Recently during the Kharif season of 1963, a few paddy plants collected from Varanasi, Jaunpur, Gorakhpur and Ballia in Uttar Pradesh showed bluish-grey blotches measuring 2-4 × 1 cm. in size on leaf-sheaths near the base. Scattered within these spots were small black pin-head-shaped pycnidia visible to the naked eye.

**Morphology of the fungus.**—Blotches on leaf-sheaths irregular, 2-4 × 1 cm., bluish-grey; pycnidia scattered, globose-ellipsoid, 120-300  $\mu$  (mostly 179-213  $\mu$ ) diameter, innate later erumpent, ostiolate, about 40  $\mu$  broad, ostiolar region dark brown with 13  $\mu$  broad pore in the centre and surrounded by 4-20 dark brown ultiseptate setae with slightly hyaline tips, raised to somewhat curved, setae radiating from the region, measuring 66-132 × 4.4-6.5  $\mu$ ; orophores not visible; spores range from 6.5 × 1.5-2  $\mu$ , ellipsoid, straight, both ends rounded, hyaline, 1-celled, 2-guttulate (one at the h end), escaping through the ostiole in long re horns but protruded out in a gelatinous ss on rupturing the pycnidium. In its diagnostic features, the fungus closely resembles *Pyrenochaeta oryzae* described by

Shirai and Miyake. Three species of *Pyrenochaeta* have so far been recorded from India—*Pyrenochaeta decipiens* from soil in Lucknow, Rai and Tewari<sup>4</sup>; *P. dolichi* on living leaves of

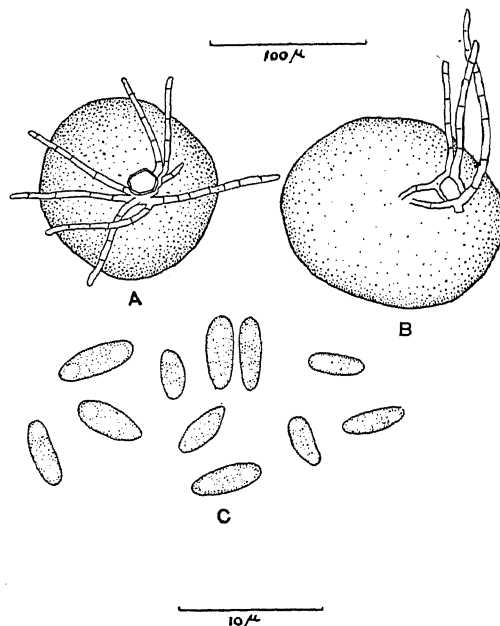


FIG. 1. A. Top view of a pycnidium of *Pyrenochaeta oryzae* with setae surrounding the ostiole. B. Side view of a pycnidium with setae. C. Spores.

*Dolichos biflorus*, Mohanty<sup>2</sup>; and *P. indica* on leaves of Sugarcane, Vishwanathan.<sup>7</sup> To the best of our knowledge *Pyrenochaeta oryzae* is a new record on *Oryza sativa* for India.

Laboratory of the Plant  
Pathologist to Government,  
Uttar Pradesh,  
Kanpur, December 2, 1963.

R. S. MATHUR.  
L. S. CHAUHAN.  
S. C. VERMA.

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### FUSARIUM WILT OF RAUVOLFIA SERPENTINA

A WILT disease of *Rauvolfia serpentina* Benth. caused by a species of *Fusarium* has been reported from Jammu,<sup>1</sup> and since its first appearance in 1960-61, the disease is becoming more and more important in the cultivated crop of *R. serpentina*.

Initial symptoms of the disease consist of wilting of individual branches. The foliage symptoms are characterized by drooping of the leaves followed by upward curling. As the disease advances, the entire plant is affected resulting in drying of the leaves and the death of the plant (Fig. 1). If the infected plants are



FIGS. 1-2. Fig. 1. *Rauvolfia serpentina* plant showing typical symptoms of *Fusarium* wilt. Fig. 2. Photomicrograph showing micro- and macro-conidia.

pulled out and the bark peeled off, yellowish-brown patches of diseased area are evident on the basal portion of the stem and on the roots. In advanced cases of infection the cortical tissue of the lower part of the stem and of the root is disintegrated. The disintegration of cortex is more prominent in seedlings and young plants where the infection results in death of the plants within a very short period.

Isolations originally made from the stem and root of the diseased plants at or just below the soil level yielded a mixture of two *Fusaria*, which were determined at the Commonwealth Mycological Institute, Kew, as *Fusarium oxysporum* Sch. and *F. solani* (Mart.) App. and Wollenw. In order to determine the exact causal organism, a large number of isolations were made and artificial infection tests were carried out. Out of 500 isolations made from the wilted plants, *Fusarium oxysporum* was obtained in most of the cases. *Fusarium solani* was obtained less frequently and species of *Aspergillus*, *Penicillium*, *Alternaria*, *Rhizoctonia* and *Gliocladium* were rarely obtained in mixture.

Single spore isolates of *Fusarium oxysporum* and *F. solani* were taken for artificial infection tests. Mass cultures were prepared on sterilized wheat. After eight days' growth, the respective cultures were separately mixed with sterile soil in pots and one to two months old seedlings of *Rauvolfia serpentina* were transplanted directly in the infested soil. Seedlings planted in soil infested with *F. oxysporum* showed symptoms of wilt, 7-8 days after planting. Those planted in soil infested with *F. solani* did not show any wilt symptoms. Re-isolations made from wilted seedlings invariably gave *F. oxysporum*. Transverse and longitudinal sections of the root and stem showed that the fungus was confined to the vascular tissue.

The cultural characters of the fungus are as follows: Mycelium extensive and cottony, pinkish-white in colour; both macro- and micro-conidia present. Macroconidia mostly 2-3 septate, rarely 1 or 4 septate, hyaline, falcate,  $17.2-34.4 \times 2.5-4.9 \mu$  ( $25.3 \times 3.8 \mu$ ). Microconidia numerous, one- to two-celled, hyaline, ovoid or slightly elongated,  $2.5-19.7 \times 1.2-4.9 \mu$  ( $8.1 \times 3.4 \mu$ ). Chlamydospores terminal and intercalary, globose, one-celled, often present in macroconidia (Fig. 2).

The description of the causal fungus agrees with *Fusarium oxysporum* Schl. *Fusarium oxysporum* does not appear to have been reported so far on *Rauvolfia serpentina*. In view of the distinctive pathogenecity of the fungus to this host and following the concept of Snyder and Hansen<sup>2</sup> which is a modification of the system of the classification of Wollenweber and Reiking,<sup>3</sup> the fungus is designated as a new *forma specialis* as *Fusarium oxysporum* f. *rauvolfii* f. Nov.

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Regional Research Lab., K. K. JANARDHANAN.  
Jammu-Tawi, D. GANGULY.\*  
December 24, 1963. AKHTAR HUSAIN.

\* Present address: Regional Research Laboratory, Jorhat (Assam).

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**A NEW HOST OF *SOROSPORIUM*  
*BULLATUM* PAVGI AND  
THIRUMALACHAR—*ARISTIDA*  
*FUNICULATA* TRIN. AND RUPR.**

DURING the course of autecological studies seeds of *Aristida funiculata* were collected from old walls of Varanasi for germination purposes. It has a cylindrical grain (caryopsis) enclosed in the awned glume (the composite structure being called spear). On examination many spears were found with torn glume. A careful examination revealed smut on the spears. As it is a new host for the fungus, the description of the same is given here:

Sori in ovaries, infecting only a few flowers in the entire inflorescence; measuring up to 4 mm. in length and from 1.5 to 2.5 mm. in breadth. Sori bulge out from the covering glume and release a mass of spores. Spore balls irregular in shape, varying from  $28\mu$  to  $125\mu$  in diameter. Spores not easily separable, sub-globose to spherical, dark brown, thick-walled, smooth, varying from  $6\mu$  to  $11\mu$  in diameter.

The fungus resembles *Sorosporium bullatum* Pavgi and Thirumalachar reported on *Aristida adscensionis* and *A. hystrix*.

I am grateful to Prof. R. Misra, for his guidance, Dr. R. Y. Roy for his help, and Director, C.M.I., Kew, for identification.

Department of Botany, C. K. VARSHNEY.  
Banaras Hindu University,  
Varanasi-5 (India),  
January 20, 1964.

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**BREEDING POTATOES FOR  
RESISTANCE TO ROOT-KNOT  
NEMATODE**

THE root-knot nematode, *Meloidogyne incognita* (Kofoed and White) Chitwood, is fast becoming a serious problem of the potato crop in the mid-hill regions of northern India. Chemical methods of control are uneconomical besides being difficult to handle. A sure answer to this problem lies in breeding varieties resistant to root-knot nematodes. So far no variety has been bred which is resistant to *M. incognita* (Williams, 1963).

In India, work on breeding potato varieties resistant to *M. incognita* was initiated at the Central Potato Research Institute in 1961. The available cultures of *Solanum tuberosum* L. and

*Solanum* spp. are now being screened for their resistance.

In the first year, 101 hybrid cultures of *Solanum tuberosum* L. were planted in a field heavily infested with *M. incognita*, with a view to test their reaction to this nematode pest. Of these, H.C. 194, a selection from the cross Kufri Red  $\times$  (Gladstone  $\times$  Taborkey), did not reveal any symptoms of attack by this pest. This hybrid was again found to be free from this pest in a trial repeated in 1962.

The resistance to this selection was further tested under laboratory conditions on plants grown in 20 cm. pots using sterilized soil. The soil was artificially inoculated with 500 second-stage infective larvae of *M. incognita*. These larvae were obtained from infested potato roots and tubers. The variety, Kufri Red, was used as control. After 60 days of inoculation roots and tubers were examined for root-knot infestation. For confirmation the roots were stained in hot cotton blue-lactophenol and studied after differentiation. The roots of the control plants showed heavy infestation whereas only in one plant of H.C. 294 four second-stage infective larvae of *M. incognita* were found in the rootlets below the epidermis. In the attacked tissues Giant cells, which appear characteristically in the attacked tissues of the diseased plants, were not also observed in this case. Although a few infective larvae had entered the roots, the absence of mature females in the potted plants and the freedom from root-knot infestation under the field conditions indicate that the culture H.C. 294 may be resistant to the attack of *M. incognita*.

The added merits of this hybrid are its high degree of resistance to high temperature and drought, and potentiality of giving a good yield. Its tubers are round, smooth, with an even red colour of the skin. The eyes are deep with well-developed medium long eyebrows.

Possessing as it does, resistance to high temperature and drought as also *Meloidogyne* spp., the variety may be expected to prove of great economic worth, especially in the shallow soils which are more prone to drought and where the infestation of this pest too is quite heavy.

Central Potato Research Institute,  
Simla, January 20, 1964.

M. L. KHANNA.  
K. K. NIRULA.

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**THE USE OF MARKER GENE IN  
HYBRID SEED PRODUCTION  
IN CABBAGE**

ONE of the commonly adopted methods for the production of hybrid seeds in cabbage is the utilization of self-incompatibility mechanism as suggested by Odland and Noll (1950). A few other methods proposed are the use of seedling marker and male-sterile genes, of which the latter is usually not stable (Rundfeldt, 1960).

24-mesh wire net cages. In the following year (1962) seeds of only one cross namely E.C. 10113  $\times$  E.C. 10122 were produced by bee pollination. The aim was to compare the performance of the  $F_1$  hybrid seeds produced by hand and bee pollinations and to ascertain the usefulness of the marker gene in producing hybrid seeds.

The results obtained in the present study have indicated the usefulness of the marker gene in producing seeds of  $F_1$  hybrids which

TABLE I  
*Performance of the parents and  $F_1$  hybrids*

Parents and Hybrids	Bee Pollinated				Hand-Pollinated			
	Average net wt. of head (kg.)	"",	Degrees of freedom	% increase over the better parent	Average net wt. of head (kg.)	"",	Degrees of freedom	% increase over the better parent
E.C. 10113 $\times$ W.Z.	1.361** (1.248)**	3.86 (3.40)	27 (29)	70.77 (88.24)	1.115*	2.30	29	39.90
W.Z. $\times$ E.C. 10113	1.108*	2.25	21	29.02	1.118	1.77	27	40.39
E.C. 8986 $\times$ W.Z.	1.773**	6.06	26	122.46	1.466**	3.25	27	83.94
W.Z. $\times$ E.C. 8986	1.781**	3.48	16	110.92	1.215*	2.64	29	52.45
E.C. 10113	0.797 (0.607)	..	27 (10)					
Wase Zenku (W.Z.)	0.794 (0.663)	..	27 (10)					
(E.C. 10122)	0.631	..	23					
E.C. 8986								

The figures in parantheses are for the second year 1962.

\* "t" greater than that at P 0.05

\*\* "t" greater than that at P 0.01.

An attempt was made to investigate the possibilities of utilizing some marker gene in hybrid seed production. The variety Wase Zenku (E.C. 10122) from Japan was found to possess a useful dominant marker gene which governed the light purple colour in the stems and dark green leaves in the seedling stage. With the help of these characters the seedlings of  $F_1$  hybrids obtained by making crosses with Wase Zenku as the pollen parent could be distinguished easily in the nursery after about 20 days of sowing.

The variety Wase Zenku (E.C. 10122) was reported earlier to have a good general combining ability as it always gave high yielding  $F_1$  hybrids when crossed with other parental lines (Swarup *et al.*, 1963). On the basis of these results the two best combinations considering both yield and quality, namely E.C. 8986  $\times$  E.C. 10122 and E.C. 10113  $\times$  E.C. 10122 were chosen for further study. Seeds of these two crosses using the variety Wase Zenku as the pollen parent and their reciprocals were produced in the year 1961 by hand pollinations as well as with the help of bees under

exhibited pronounced heterosis (Table I). This method is comparatively easier and less time-consuming than the other procedures employed for this purpose. It may, however, be mentioned that since the percentage of the hybrid seedlings distinguishable with the help of the marker gene was about 32 to 38 only, it would be necessary to increase the seed rate of the  $F_1$  hybrids to about two to three times the normal quantity required, approximately 300 to 600 gm. per acre instead of the usual seed rate of 100 to 200 gm. It is possible to reduce the seed rate appreciably by increasing the percentage of cross-pollination. This can be accomplished conveniently by growing larger number of plants of the male parent than those of the female, adopting suitable planting layouts, like planting in concentric circles or growing male parent all round the female and by planting in the open in isolated fields.

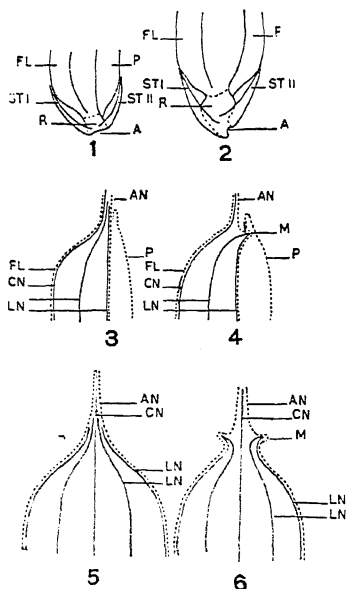
Vegetable Breeding Sub-Station VISHNU SWARUP,  
Katrain (Kulu Valley), Panjab,  
Division of Horticulture, H. S. GILL.  
Indian Agricultural Research,  
Institute, New Delhi, November 8, 1963.

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### NEGLECTED CHARACTERS IN TAXONOMY OF GENUS *ORYZA* L.

Two characters—rachilla and mucro—which were referred to only in early literature on morphology of the genus *Oryza*, were found to be very valuable in taxonomy. A modified key employing these characters is under preparation.

The term rachilla<sup>1</sup> refers to the axis of spikelet between the pedicel and the point of attachment of fertile lemma. Bor<sup>2</sup> and Backer<sup>3</sup> refer to this structure as callus. Most of the species of *Oryza* were studied by us for this character. Rachilla can be either straight as in *O. latifolia* Desv. or comma-shaped as in *O. sativa* L. (Figs. 1-2). A point of further interest is the



FIGS. 1-6. Figs. 1, 3 and 5. *O. latifolia* showing straight rachilla and horizontal articulation (Fig. 1), 2nd non-mucronate lemma in lateral (Fig. 3) and flattened views (Fig. 5). Figs. 2, 4 and 6. *O. sativa* showing comma-shaped rachilla and oblique articulation (Fig. 2), and mucronate lemma in lateral (Fig. 4) and flattened views (Fig. 6).

Abbreviations: A, articulation; R, rachilla ST I and ST II, Sterile lemmas 1 and 2; F. L., fertile lemma; P, palea; AN, awn M, mucro; LN, lateral nerve and CN, central nerve.

perfect correlation between the nature of rachilla and of spicular articulation with pedicel.

Roschevicz<sup>4</sup> refers to this articulation as horizontal or oblique. It is recorded by us that all species with straight rachilla exhibit horizontal articulation (as in *O. latifolia* Desv.) while those with comma-shaped rachilla show oblique articulation (as in *O. sativa*).

The term mucro was used by Backer<sup>3</sup> for a deflected knob-like emergence on either side of apiculus in fertile lemma. Watt<sup>5</sup> refers to this structure as "glandular process". It is observed by us that this structure results from fusion of a pair of lateral veins on either side of the central nerve which in itself continues into the awn or awn rudiment. Mucro is most pronounced in *O. glaberrima* Steud. and less so in *O. brachyantha* Cheval. et Roehr. All the nerves of fertile lemma enter into the awn of non-mucronate species while only the central nerve does so in mucronate species.

Variation in mucro is significantly correlated with that of rachilla. All the species which are non-mucronate invariably exhibit a straight rachilla and horizontal articulation while those which are mucronate exhibit comma-shaped rachilla and oblique articulation. No exception to this has so far been met with in the genus *Oryza* and hence all the three characters can be visualised as an inseparable complex as is evident from the species listed below:

Group I: Straight rachilla, horizontal articulation and non-mucronate lemma: *O. latifolia* Desv., *O. alta* Swallen, *O. grandiglumis* (Doell) Prod., *O. minuta* Presl., *O. malampuzensis* Krishn. et Chandr., *O. eichiengeri* Peter, *O. punctata* Kotschy ex Steud., *O. officinalis* Wall. ex Watt, *O. meyeriana* (Zoll. et Mor.) Baill., *O. ridleyi* Hook. f., *O. longiglumis* Jansen, *O. tisseranti* Cheval. et Roehr. and *O. coarctata* Roxb.

Group II: Comma-shaped rachilla, oblique articulation and mucronate lemma: *O. sativa* L., *O. rufipogon* Griff., *O. barthii* Cheval., *O. glaberrima* Steud., *O. breviligulata* Cheval. et Roehr. and *O. breviligulata* Cheval. et Roehr.

Long grain and long anthers in contrast to short grain and short anthers were used to distinguish the species of the Sect. *Sativa* from those of *officinalis* by Ghose and Richharia<sup>7</sup> who proposed the bifurcation of the Sect. *sativa* Roshev. The above characters are not dependable (e.g., in *O. australiensis*, *O. alta* and *O. punctata*). The character complex described here—rachilla, articulation and mucro—serves as an unmistakable criterion for distinguishing

the above two groups. Further, *Sect. angustifolia* of Tteokka<sup>8</sup> (syn. *Ser. brachyantha* of Sampath<sup>9</sup>) is heterogeneous for the above character complex and hence may have to be further divided.

All the interspecific hybrids available were screened for these characters. In all the  $F_1$  hybrids between mucronate and non-mucronate species, the complex of characters—non-mucronate lemma, horizontal articulation and straight rachilla—exhibit dominance while in intra-group  $F_1$  hybrids, the characters remain constant. Ploidy differences in *O. sativa* (haploid, diploid, triploid and tetraploid were studied) do not alter the mucronate condition.

S. D. SHARMA.

S. V. S. SHASTRY.

Botanical Substation,  
PUSA Ind. Agric. Res. Inst.,  
New Delhi-12, December 2, 1963.

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**NEW RECORD OF APANTELES  
LEPTAURA C., PARASITISING  
TERASTIA METICULOSALIS GN.  
IN INDIA**

DURING the studies on the biology of *Terastia meticolosalis* Gn., a borer on *Erythrina indica*, a parasite, was obtained from the larva. The last instar larvæ which were ready for pupation were parasitised and instead of transforming

into pupæ, they came out several times from their tunnels, became dizzy and finally died. After three days a white cocoon was found attached to it, from which a hymenopterous parasite emerged after eight days (Fig. 1).

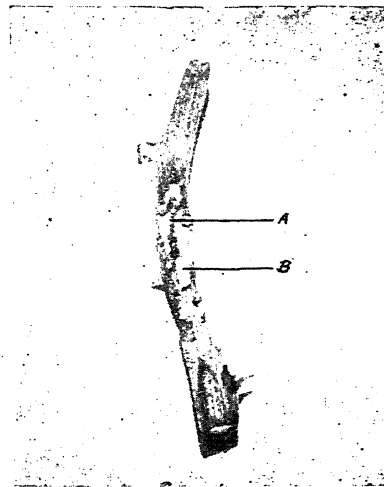


FIG. 1. A. Parasitised larva of *T. meticolosalis*.  
B. Pupa of *A. leptaura*.

The parasite was sent for identification to Dr. W. H. Anderson, Chief, Insect Identification and Parasite Introduction, U.S.D.A. The parasite was identified as *Apanteles leptaura* Cam. Mr. Muesebeck states that it is the first record of the occurrence of this parasite in India from *T. meticolosalis*. It was recorded previously from Ceylon from a larvæ in stems of dadap and subsequently from *T. meticolosalis*. Anderson further states that the only published record for the species is Ceylon as its known distribution.

The author acknowledges his thanks to W. H. Anderson.

Dept. of Entomology, MIR HAMID ALL  
Plant Pathology,  
College of Agriculture,  
Rajendranagar, Hyderabad (A.P.),  
January 31, 1964.

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 REVIEWS
 

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**Magnetism, Volume III—A Treatise on Modern Theory and Materials.** Edited by George T. Rado and Harry Suhl. (Academic Press, New York and London), 1963. Pp. 623. Price \$ 18.00 or 128 sh. 6 d.

This treatise attempts to provide an up-to-date and reasonable concise summary of our understanding of magnetically ordered materials. Thus it deals almost exclusively with ferromagnetism, ferri-magnetism and antiferromagnetism, i.e., with co-operative phenomena characterised by ordered arrangements of magnetic movements subject to strong mutual interactions. The sub-title indicates the range of topics dealt with, viz., spin arrangements and crystal structure, domains and micro-magnetics. The discussions range from quantum mechanical and abstract statistical models to analysis of actual magnetic structures; from the theory of spin interactions in solids to the phenomenology of ferromagnets; and from electronic and nuclear resonance effects to neutron diffraction and optical phenomena in magnetically ordered materials. The entire subject is treated from both theoretical and experimental points of view with an emphasis on the physical bases, potentialities, and limitations of magnetism.

The field is covered in the twelve articles, each written by specialists in this field, listed below: Magnetism and Crystal Structure in Non-metals by J. B. Goodenough; Evaluation of Exchange Interactions from Experimental Data by J. S. Smart; Theory of Neutron Scattering by Magnetic Crystals by P. G. de Gennes; Spin Configuration of Ionic Structures: Theory and Practice by E. F. Bertaut; Spin Arrangements in Metals by R. Nathans and S. J. Pickart; Fine Particles, Thin Films and Exchange Anisotropy by I. S. Jacobs and C. P. Bean; Permanent Magnet Materials by E. P. Wohlfarth; Micromagnetics by S. Shtrikman and D. Treves; Domains and Domain Walls by J. F. Dillon, Jr.; The Structure and Switching of Permalloy Films by D. O. Smith; Magnetization Reversal in Non-metallic Ferromagnets by E. M. Gyorgy; Preparation and Crystal Synthesis of Magnetic Oxides by C. J. Kriessman and N. Goldberg.

It will be evident that the book can serve as a research tool and reference work for the specialist. It should also enable a student with

a physics or chemistry background to gain a grasp of the details of the subject.

C. V. R.

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**Crystallographic Data on Metal and Alloy Structures.** Compiled by A. Taylor and Brenda J. Kagle. (Dover Publications, Inc., New York), 1963. Pp. 263. \$ 2.25.

This is a unique compilation of the latest crystallographic data on alloys, compounds, and the elements, with lattice spacings expressed uniformly in absolute Angstrom units. The first table, Alloys and Intermetallic Compounds, lists over 2,300 different compounds, arranged alphabetically for easy reference. In parallel columns there are listed the System, Structure Type and ASTM Index Data; the Space Group; the lattice constants in absolute Angstrom units; and the Molecule/Unit cell for each compound. The second table supplies the same data for nearly 700 Borides, Carbides, Hydrides, Oxides, and Nitrides. The last table contains all the necessary data on the crystal structure of 77 elements, listed alphabetically; general remarks; temperature of crystallization; structure; lattice constants expressed in absolute Angstrom units; and X-ray density.

C. V. R.

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**Pointers and Pathways in Research.** (Published by CIBA of India Limited, Bombay), 1963. Pp. 108 with 59 illustrations.

This is a brochure tastefully printed, illustrated and produced to commemorate the opening ceremony of the CIBA of India's Research Centre at Goregaon, Greater Bombay. It reproduces a series of lectures given on the occasion by six distinguished scientists, viz., the following: (1) New Horizons in Organic Chemistry by Lord Todd, (2) Art and Science in the Synthesis of Organic Compounds by R. B. Woodward, (3) Arterial Occlusion by Sir George Pickering, (4) Iron-Containing Antibiotics and Microbic Growth Factors by V. Prelog, (5) Problems in the Encouragement of the Advance of Science by Alexander von Muralt and (6) Sideliights on Synthetic Dyes by K. Venkataraman. The lectures, as is to be expected, are very stimulating reading.

C. V. R.

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**Lectures in Theoretical Physics, Volume V.**  
Edited by W. E. Brittin, B. W. Downs and J. Downs. (Interscience Publishers, John Wiley & Sons, New York), 1963. Pp. vii + 585. Price \$12.0.

The volumes in this series are issued annually and they contain the material presented each year in Lectures at the Summer Institute for Theoretical Physics, University of Colorado, Boulder. The present volume covers the topics delivered at the Institute in the summer of 1962. As can be seen from the following titles, the topics cover a wide range and are largely independent: Behaviour of De Broglie Wave and Wave Packets by W. H. Furry; Recent Developments in Scattering Matrix Theory of Particles and Resonances by A. O. Barut; Theories of Ferroelectricity in  $\text{KH}_2\text{PO}_4$  by E. A. Uehling; Topics in Quantum Electronics by N. Bloembergen; Group Theoretical Approaches to Nuclear Spectroscopy by L. C. Biedenharn; Dynamics of Electrons in Crystals by E. I. Blount; Theory and Practice of the Fermi Surface of Metals by J. C. Philips; The Universe in the Light of General Relativity by J. A. Wheeler; Mach's Principle as Boundary Condition for Einstein's Field Equations by J. A. Wheeler.

Many of the topics selected are not new in themselves but each one is self-contained and the presentation has some novel features which will interest the reader. The lectures, in general, review recent work on the subjects concerned. The two articles by Wheeler deserve special mention as they raise some interesting questions regarding cosmological theories.

As the lectures are intended for an audience of graduate students the presentation is simple and coherent. The lecturers being active workers in the field of their choice evince enthusiasm in their attempt at transmitting their ideas to young scientists interested in current research.

A. S. G.

**Annual Review of Biochemistry, Volume XXXII.**  
(Annual Review Inc., Palo Alto, California, U.S.A.), 1963. Pp. vii + 864. Price \$9.00.

The *Annual Review of Biochemistry* for the year 1963 (Vol. 32) contains 21 articles contributed by 31 authors who are well known for their investigations in the fields concerned. A variety of topics have been selected for review and in many cases they are continuations of previous reviews that had appeared, and bring the subjects up to date, focusing attention on recent results. There are articles on

chemical structure and construction of RNA and DNA molecules, biochemistry of viruses, study of enzyme systems, structure of globular proteins by X-ray diffraction studies; and on lipid, carbohydrate and amino-acid metabolisms. On the medical side we have articles on the biochemistry of cancer, and on neurochemistry. On the experimental side there are descriptive articles dealing with latest developments in gas chromatography and mass spectrometry.

But the pride of place in this volume has been legitimately taken by an absorbing article entitled "Lost in the Twentieth Century" by Albert Szent-Gyorgyi. It forms the Prefatory Chapter. Szent-Gyorgyi has always something entertaining and stimulating to say and the present article is no exception. It is a scientific autobiography which recounts the author's adventures and discoveries in biological science, against the background of turbulent war-torn years in Europe. It is an essay on 'science and belief' which brings into relief the dilemma of an honest believer who looks askance at the encroachment of science into the domain of 'life', who prays to God when he is sick but does not forget to keep penicillin by his bedside, who erects lofty images of the Buddha and Christ on hill-tops to worship, but all the same is cautious to protect them by lightning conductors. It is a thought-provoking article and the author calls it, in his characteristic way, "an obituary written by the fellow himself".

A. S. G.

**The Control of Lipid Metabolism.** Edited by J. K. Grant. (Academic Press, Inc., London, New York), 1963. Pp. 191. Price 37 sh. 6 d.

The last decade has witnessed a rapid development in the elucidation of the biosynthetic mechanisms of many lipid materials, like triglycerides, phospholipids, cholesterol, fatty acids, etc. In all of these cases, the development has been rather dramatic and from some unexpected quarters. Against this background, the decision of the Biochemical Society, London, to organise a Symposium for discussing the "Control of Lipid Metabolism" appears to be an appropriate one. The present book is the proceedings of the Symposium No. 24 of the Society.

Various aspects of the biosynthesis of saturated and unsaturated fatty acids in animals, micro-organisms and plants, as well as several regulatory factors like acetyl CoA carboxylase activity, isocitrate and citrate, that control these processes in fasting, normal and diabetic animals

are discussed. Some of the interesting topics of this volume are, the possible mechanisms of biosynthesis of unsaturated fatty acids, the control of fatty acid synthesis at the cellular level, the hormonal control of cholesterol metabolism and the mobilization of fatty acids.

The present book should be of considerable value to those who are working on lipid metabolism, and are trying to keep abreast of this rapidly developing field. J. GANGULY.

**Analytical Methods for Pesticides, Plant Growth Regulators and Food Additives, Volume I.** (*Principles, Methods and General Applications*). Edited by Gunter Zweig. (Academic Press, Inc., New York and London), 1963. Pp. xiii + 637. Price \$24.00.

This publication is to appear in four volumes of which Volume I is published. The objective of the Editor and his collaborators in bringing out these volumes is to bring together information scattered in a large number of publications which are not easily accessible to analysts in Government and Industrial Laboratories. Collating such information has become all the more necessary because of the rapidly increasing number of chemicals that are being formulated for growth, processing and food preservation, and because it is not possible for analysts to be conversant with the analysis of newer formulations. The treatment of the subject is thorough and exhaustive.

The first section deals with the general principles relating to the analyses of formulation, residue, food adulterants, extraction, clean-up procedures and toxicological testing methods. The second section is devoted to general methods of analysis citing examples relating to pesticides and food adulteration. The third section covers general application of methods in residue analysis in food and dairy industries, residue in meat, and methods of application in Government Laboratories in U.S.A.

The analytical method dealt with covers the fields of spectrometry, gas and paper chromatography, total halides, neutron activation, isotopic and enzymatic methods and bio-assay with insects and plants and analysis of microbiological pesticides. The information furnished deals with most up-to-date methods in current use in the analyses of pesticides, food adulterants and residues in food. For each method the instruments and apparatus required are described and their capabilities discussed. A separate chapter

has been devoted to statistical evaluation of analytical results.

For a country like the U.S.A. which has made considerable advances in agriculture, live-stock and dairy industries, and in which plant and animal protection, food preservation and development and control of plant growth have become widespread, it is found very necessary to adopt measures to check malpractices. Towards this end a number of testing laboratories both in the private and the public sectors have been established and the U.S. Government have passed laws to maintain the required standard to prevent health hazards. These volumes no doubt will be of great value to analysts in that country. Their worth will also be appreciated in countries of Europe and the United Kingdom in which development of agriculture and industries is progressing on parallel lines to those in U.S.

It is hoped that in our country also the importance of establishing modern testing laboratories as ancillary to some of our National Laboratories and Research Institutes will be realized and more units set up in our phased plans to help (and also to check) licensed manufacturers of pesticides, plant growth regulators, food products, etc., to maintain production of quality products according to standard specifications.

L. S. S. K.

#### Books Received

*Mathematics in Science and Engineering* (Vol. 9)

—*Non-Linear Wave Propagation with Applications to Physics and Magnetohydrodynamics.*

By A. Jeffrey and T. Taniuti. (Academic Press, New York-3), 1963. Pp. ix + 369. Price \$12.00.

*Craigie's Neuroanatomy of the Rat* (Revised and expanded). By W. Zeman and J. R. M. Innes. (Academic Press, New York-3), 1963. Pp. ix + 230. Price \$8.50.

*Gas Chromatography.* By L. Fowler. (Academic Press, New York-3), 1963. Pp. xiv + 270. Price \$10.50.

*The Physiology and Biochemistry of Herbicides.* Edited by L. J. Audus. (Academic Press, New York-3), 1964. Pp. xix + 555. Price 110 sh.

*Selected Papers of Ernst George Pringsheim.* By C. B. van Niel. (Institute of Microbiology, Rutgers, The State University, New Brunswick, New Jersey), 1963. Pp. 331. Price \$6.50.

*The Proteins, Composition, Structure and Function* (2nd Edition). Edited by Hans Neurath. (Academic Press, New York-3), 1963. Pp. xi + 665. Price Subs.: \$19.50; Reg.: \$22.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Utkal University has awarded the Ph.D. Degree in Chemistry to Shri Pranabandhu Tripathy for his thesis entitled "Spasmolytics and Photographic Sensitisers derived from Thiazoles and Related Compounds".

Osmania University has awarded the Ph.D. Degree in Technology to Shri S. Narasimha Rao for his thesis entitled "Particle-Fluid Heat Transfer Coefficients in Fluidized Beds".

### Institution of Chemists (India)

The Fifteenth Associateship Examination of the Institution of Chemists (India) will be held in November, 1965. The last date for Registration is 30th November 1964. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

### Symposium on "Behaviour of Soil Under Stress"

It is proposed to hold a symposium on "Behaviour of Soil Under Stress" in January 1965 at the Indian Institute of Science, Bangalore-12.

The scope of the symposium is indicated by the following topics: A. Behaviour of soils with special reference to tropical conditions: (i) Analytical and experimental studies on saturated soils; (ii) Studies on partially saturated soils; (iii) Behaviour of artificially strengthened soils; (iv) Special problems pertaining to tropical soils. B. Behaviour of soils under time-dependent loading: (i) Behaviour of soils under vibratory load; (ii) Soil problems in seismic zones. C. Interaction between foundation structure and soil.

Papers presented at the symposium together with discussions will be brought out as a publication.

Contribution of papers on any of the topics listed above is invited. Authors should send the title and summary (about 300 words) of the paper by the end of June 1964 and three copies of the final paper in publishable form by the middle of October 1964, to the Convener of the Symposium, Civil and Hydraulics Engineering Department, Indian Institute of Science, Bangalore-12.

### Australasian Conference on Hydraulics and Fluid Mechanics

The Second Australasian Conference on Hydraulics and Fluid Mechanics to be held at the University of Auckland, New Zealand, from 6th to 12th December, 1965, invites papers on all aspects of Fluid Mechanics, Hydraulics and Hydraulic Engineering.

Interested persons or organisations from all countries are invited to write to the Convener (A. J. Raudkivi) of the Conference C/o The University of Auckland, School of Engineering, Ardmore College Post Office, Auckland, New Zealand.

The First Conference was held in Perth, Western Australia, in 1962, and drew a good attendance from seven different countries besides Australia.

### Tainting of Fruit and Vegetable Products by Agricultural Chemicals

Much has been written in recent years on the possible hazards due to the indiscriminate use of chemicals in agriculture. Comparatively little publicity has been given to the effect which such substances might have on the taste of products prepared from materials so treated. A recent publication (*Technical Bulletin No. 8* of the Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping, Campden), however, directs attention to this aspect of the subject. The results of more than 400 controlled field trials involving some seventy agricultural chemicals (insecticides, herbicides and fungicides) are tabulated and discussed, together with the findings of the expert testing panel on the corresponding canned and frozen fruits and vegetables. The following crop protection chemicals have been found to produce taints on certain named fruits and vegetables in the Campden tests: aldrin, benzene hexachloride, captan, chlorbenside, dicloran, ferbam, griseofulvin, metaisosystox, nabam, sevin, thiram, zinc-activated PETD, zineb and zitam. In a few instances the off-flavour was throughout to be due to a previous sulphur treatment. It is emphasized that the presence of a taint is not associated with any health hazard. The palate can be a much more sensitive instrument for detecting taints than the most refined chemical or physical methods of analysis, and some taints

may be detected at concentrations of less than one part in  $10^9$ . It would seem possible, therefore, that consumer preferences may assist in controlling the extent to which chemicals are used in farms, market gardens and orchards.

### The Eye of *Copilia*

Exner described the visual apparatus of the copepod *Copilia*, which he examined at Naples in the 1880's.

According to Exner, each of the lateral eyes of *Copilia* has a pair of lenses. The anterior lenses are large, and exceptionally wide separated. The posterior lens of each eye lies a great distance behind the anterior lens—half-way along the extraordinarily transparent body of the animal—so that it is not at first obvious that it has any connexion with the eye. The most striking feature reported by Exner is that this second posterior lens was "in continuous and lively movement", apparently moving across the image plane of the anterior lens. From his description, it appears that there is no retina but rather a single functional receptor unit, transmitting its information to the central brain down a single pathway.

With what we now know about transmitting spatial information by conversion into a time-series by scanning, as in television, it seemed possible that Exner was describing an organism the eye of which works on a principle now very familiar to the engineer.

Recent study on the curious eye of *Copilia* has been reported in *Nature* by Gregory, Ross and Moray. Their results on live specimens of *Copilia* collected from the Bay of Naples seem to confirm the independent movement of the eye parts as reported by Exner, and the mechanism is akin to "scanning". The *Copilia* eye seems to play an important role in the eye's evolutionary sequence.—(*Nature*, 1964, 201, 1166.)

### Maser-Stimulated Raman Radiation in Calcite

It is now well known that when intense laser radiation (of frequency  $\omega_0$ ) is focused on a Raman-active substance (whose characteristic Raman vibration is  $\omega_r$ ) stimulated radiation of several orders of shifted frequencies,  $\omega_0 \pm n\omega_r$ , appear in the scattering in the forward direction.

One of the most striking features of this stimulated Raman scattering is the specific directional emission of these Stokes and anti-Stokes radiations. The scattering takes place along well-defined cones so that if received on a screen there appear coloured concentric circles produced by the altered frequencies.

In a communication to *Physical Review Letters* (16 March 1964) B. P. Stoicheff and R. Chiao report their experimental studies of this angular dependence of stimulated scattering in calcite. In the experiment a calcite crystal 5 to 10 cm. long was placed in the path of the focused external beam from a giant pulse ruby laser. The crystal was oriented so that the laser beam ( $\lambda$  6943), which was linearly polarized, travelled through the crystal as the ordinary ray. In this orientation the vibrational Raman frequency of  $1085.6 \text{ cm}^{-1}$  was excited producing several orders of Stokes and anti-Stokes radiation.

The experimenters report the following observations: (a) four orders of anti-Stokes emission in well-defined cones; (b) diffuse first-order Stokes emission with cones of absorption; and (c) a well-defined cone of second-order Stokes emission. The reported wavelengths are  $8174.9$  ( $\omega_0 - 2\omega_r$ );  $6456.0$  ( $\omega_0 + \omega_r$ );  $6033.2$  ( $\omega_0 + 2\omega_r$ );  $5662.3$  ( $\omega_0 + 3\omega_r$ ) and  $5334.4$  ( $\omega_0 + 4\omega_r$ ).

Since the refractive index of calcite is precisely known it has been possible to predict accurately the maxima and minima of anti-Stokes and Stokes radiation on the basis of the combinations of the wave-vectors involved. The results of observations were found to agree with the theory of stimulated Raman scattering proposed by Garmin, Pandarese and Townes (see also Hellwarth's article, *Curr. Sci.*, 5 March 1964). According to this theory the first act in the process of stimulated scattering is the production of diffuse first-order Stokes radiation ( $\omega_0 - \omega_r$ ); the subsequent process following this is the vectorial interaction between ( $\omega_0 - \omega_r$ ) and the incident laser light  $\omega_0$  which results in producing directional higher order Raman effects and other observed characteristics.—(*Phys. Rev. Letters*, 16 March 1964.)



## TOXIC AMINO-ACIDS OF PLANTS

V. V. S. MURTI AND T. R. SESHADRI

*Department of Chemistry, Delhi University, Delhi*

### Occurrence of Free Amino Acids

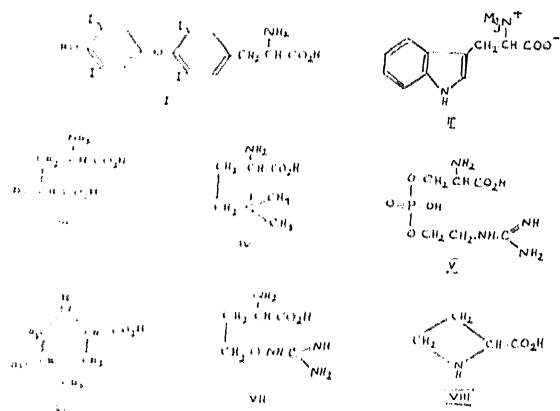
THE earliest amino acid known to occur free in Nature was leucoparinine which was discovered as early as 1802 in the juice of *Argemone officinalis*. With the recognition of the vital importance of proteins to animals and plants by the middle of the last century and the later discovery that amino acids form the main structural units of proteins, emphasis was laid on the determination of the amino acid constitution of proteins. It was established that almost all proteins are built up of about 20 common amino acids; and a few contain one or more atypical amino acids. The identification and characterization of the protein amino acids and the finding that some of them nutritionally beneficial form an important landmark in modern biochemistry.

Amino acids occur not only as components of proteins and peptides but also free in plants and animals. Prior to 1940 no significant interest was shown in the non-protein amino acids occurring in Nature. In fact not many of them were studied at that time because of the laboratory methods needed for their isolation and characterization. The discovery of paper partition chromatography in 1944 and the development of newer isolation and analytical procedures, namely ion exchange chromatography and electrophoretic techniques, have initiated a new era in natural amino acid chemistry. This has resulted in the discovery of a large number of unusual amino acids and of their simple derivatives in animal and plant sources; leguminous plants are particularly rich in new amino acids. Some of the more novel natural amino acids have not been found in other kinds of natural products and some have considerable biological activity. Hence, great interest is being taken in them and improved methods of detection, isolation, characterization and structure elucidation (UV, IR, NMR and mass spectroscopy, optical rotatory dispersion, vapour phase chromatography) are being employed.

The fundamental importance of amino acids and proteins to living organisms has been well established; some of the amino acids are essential since many higher animals cannot synthesize them but depend upon their food sources. It is also known that a number of proteins and polypeptides have important physiological func-

tions, e.g., enzymes (pepsin) and hormones (thyroglobulin and insulin). In most of these cases the entire protein molecule seems to be playing the part; however, the hormonal activity of thyroglobulin is mainly due to thyroxine (I), an amino acid of unique structure having four iodine atoms. Some are highly toxic, e.g., toxalbumin, diphtheria toxin and botulinus toxin. A few simple amino acids which have poisonous properties were also known earlier, e.g., hypaphorine (II) occurring in *Erythrina hypaphorica*.<sup>2</sup>

Chart I



The occurrence of uncommon amino acids in plants, particularly food plants, raises the question of their role in human and animal nutrition. These compounds may be metabolized and used beneficially or they may be excreted unchanged while some are positively harmful.  $\gamma$ -Hydroxy glutamic acid (III) is rapidly converted into aspartic and glutamic acids in the rat.<sup>3</sup> S-methyl methionine (IV) found in cabbage juice prevents the toxicity of sulphanilamide for *E. coli*<sup>4</sup> and homocysteine (V) is important for muscular contraction in the earthworm.<sup>5</sup> 5-Hydroxy pipercolic acid (VI) found in edible dates is excreted unchanged.<sup>6</sup> However, nutritionally injurious effects due to uncommon amino acids and related substances attract more attention. A number of these compounds have structural similarity to protein amino acids<sup>1</sup> and it should be expected that they can act as antimetabolites in living organisms; thus canavanine (VII) occurring in the jack bean (*Canavalia ensiformis*) and many other plants of the *leguminosa*<sup>7</sup> competes with

arginine and inhibits the growth of the *Neurospora*.<sup>8</sup> Azetidine-2-carboxylic acid (VIII) which is widely occurring,<sup>9</sup> replaces proline in the proteins of *Phaseolus vulgaris* and *Escherichia coli* and the progressive replacement leads to growth inhibition and death.<sup>10</sup> In bacteria the antimetabolite action of the structural analogues of amino-acids is not due to the inhibition of the synthesis of bacterial proteins but the promotion of the synthesis of abnormal proteins.<sup>11</sup>

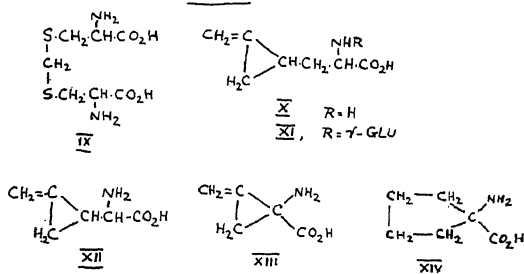
No systematic study of the toxic properties of the free amino-acids of plants seems to have been made. Food poisoning resulting in considerable suffering and loss of life is well known. The toxic substances usually implicated in such cases are; (i) pesticides and other agricultural chemicals containing phosphorus or arsenic and (ii) poisonous products of plant origin like oxalic acid, fluorine-containing acids, *Senecio* alkaloids,<sup>12</sup> cyanogenetic glycosides and aflatoxins. It does not seem to be sufficiently well realised that deleterious compounds could be the normal constituents of edible materials also; instances are known of people suffering from serious illness after having eaten what are usually thought to be harmless foodstuffs like fruits, pulses or vegetables. Only when these are forced into attention by serious epidemics or calamities detailed investigations are carried out and in some cases amino-acids have been implicated and have aroused interest in their physiological properties.

#### TOXIC AMINO-ACIDS OF SEEDS AND FRUITS

One of the early examples of poisoning due to edible materials is the case of 'djenkol' beans (Java beans, *Pithecellobium lobatum*) indigenous to Java and which are commonly eaten by the local people.<sup>13</sup> The toxic compound is a novel sulphur-containing amino-acid, djenkolic acid (IX),<sup>14-15</sup> which occurs free in the beans<sup>14</sup> and is excreted unchanged in the urine and imparts a foul smell to it. Djenkolic acid is structurally closely analogous to cystine and contains a methylene group between the sulphur atoms; this small modification has converted the useful cystine into a toxic compound. Its synthesis is conveniently carried out by reacting cysteine with formaldehyde in strongly acid solution<sup>15</sup>; a similar process is also likely for its biosynthesis in the plant. Djenkolic acid has also been found in the seeds of other *Pithecellobium* species, *Albizia lophantha* and many other plants of the *Mimosaceae*.<sup>17</sup> It is also reported to have been isolated from the acid hydrolysates of calf plasma, liver and muscle

proteins.<sup>18</sup> N-Acetyl djenkolic acid is present in the seeds of *Acacia farnesiana*.<sup>19</sup>

Chart 2



An instance of poisoning due to fruits is common in West Indies. The Ackee tree (*Blighia sapida*) is widely grown there and its fruits are very popular and are a favourite article of diet; however, the fruits and the seeds are very poisonous and the unripe ones are more toxic than the ripe fruits and are frequently the cause of fatalities in children.<sup>20</sup> The toxicity is due to an unusual amino-acid, Hypoglycin A (X)<sup>21-23</sup> and its  $\gamma$ -glutamyl derivative, hypoglycin B (XI)<sup>24</sup> which contains the rare cyclopropane ring system. Hypoglycin A is twice as toxic as hypoglycin B. Both the compounds have strong hypoglycaemic activity and cause 'vomiting sickness', characterised by a severe depletion of liver glycogen and a rapid fall in the blood sugar level resulting in coma and death. Their mode of action appears to be different from that of insulin. Hypoglycin A is now being manufactured for evaluation as an oral hypoglycaemic agent.<sup>25</sup>

The lower homologue of hypoglycin A,  $\alpha$ -(methylene-cyclopropyl)-glycine (XII) is present in litchi seeds (*Litchi sinensis*)<sup>26</sup> and has some hypoglycaemic action. Recently methylenecyclopropyl-L-carboxylic acid (XIII) has been found to occur in the fruits of perry pears, cider apples<sup>27</sup> and of cowberry and cranberry.<sup>28</sup> The interesting properties of these compounds have stimulated studies of related substances and led to the finding that cyclopentane-L-amino-L-carboxylic acid (XIV) and its derivatives have antitumour activity.<sup>29</sup>

#### AMINO-ACIDS OF THE *Lathyrus* AND THE *Vicia* SPECIES

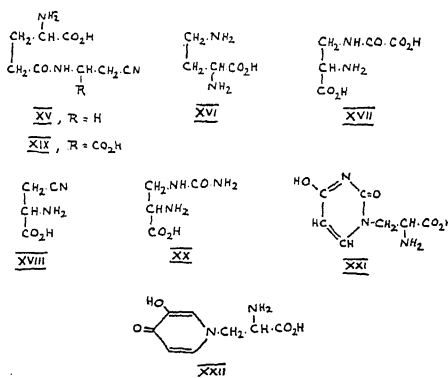
The seeds of the *Lathyrus* species (*Leguminosae*) have been known to cause severe toxic effects in animals and humans and to be responsible for the well-known disease 'lathyrism'. Two kinds of lathyrism are recognised, viz., osteolathyrism (odoratism) where

pathological changes occur in the bones resulting in skeletal deformities and neurolathyrism in which the muscles of the limbs, especially of the legs, are paralysed sometimes resulting in convulsions and death in severe cases. Different species of *Lathyrus* cause one or the other type of disease though sometimes both types may be caused by the same species.<sup>30-33</sup>

The osteolathrogenic factor of the seeds of *L. odoratus*, grown in America and the Mediterranean countries, was identified as  $\gamma$ -glutamyl- $\beta$ -aminopropionitrile (XV)<sup>30-34</sup>; it has since been found in other species of *Lathyrus* also.<sup>35</sup> The neurolathrogenic compound of the seeds of the American species *L. latifolius* and *L. sylvestris* is  $\alpha\beta$ -di-aminobutyric acid (XVI).<sup>36</sup> This basic amino-acid was earlier known as a constituent of some antibiotics, e.g., circulin, comirin and the polymyxins; but its neurotoxic properties have not been noticed till recently. It is present in the free state in the seeds of other *Lathyrus* species<sup>35</sup> and many other plants.<sup>37</sup> The wide occurrence of this toxic amino-acid emphasizes the need for a careful survey of food plants for the presence of this compound.

N-Acetyl- $\alpha\gamma$ -diaminobutyric acid is present in the latex of *Euphorbia pulcherrima*; the location of the acetyl group is uncertain. The latex of the *Euphorbia* species contains high concentrations of free amino-acids many of them still to be identified.<sup>38</sup>

Chart 3



*Lathyrus sativus* seeds have been implicated for a long time as responsible for lathyrism in some parts of India; this disease is mainly of the neurological type.<sup>39</sup> The chief neurotoxic substance was recently obtained in crystalline form and its structure was established as  $\beta$ -oxalylamino alanine (XVII).<sup>33,40</sup> This compound causes nervous derangement in young

chicks but rats and mice are not appreciably affected. This might be the reason for many of the earlier contradictory reports regarding the toxicity of the seeds of *L. sativus* when different test animals were employed. Preliminary experiments indicated that these seeds also contain small amounts of osteotoxic substances.<sup>33</sup> Kumagai *et al.* have reported the isolation of a blood sugar lowering compound from the leaves and stems of *Lathyrus palustris* var. *macranthus*; they consider it to be a "natural" form of oxalic acid.<sup>41</sup> Recent studies (E. A. Bell, personal communication) have shown that  $\gamma$ -oxalyl-amino alanine has so far been detected in 20 species of *Lathyrus* and its higher homologue,  $\alpha$ -amino- $\gamma$ -oxalylamino butyric acid occurs in 9 species.

The seeds of *Vicia sativa* and *V. angustifolia* are closely similar to those of the *Lathyrus* species and previous reports attributed the poisonous effects of the latter to contamination with *Vicia* seeds. Ressler identified the neuroactive compound of the two *Vicia* seeds as  $\beta$ -cyanoalanine (XVIII)<sup>31</sup>; recently  $\gamma$ -glutamyl- $\beta$ -cyanoalanine (XIX) has been found to be present in *Vicia sativa*<sup>42</sup> and *Lathyrus sylvestris*.<sup>43</sup>

The occurrence of neuro- and osteotoxic substances in these legumes has stimulated interest in the mechanism of their action.<sup>44,45</sup> The chief osteolathrogenic principle is  $\beta$ -aminopropionitrile (BAPN) which has bone-deforming properties and causes connective tissue damage; other amino-acid nitriles also have similar action. The free amino group of BAPN is essential for physiological activity and its acyl derivatives are inactive unless they could be hydrolysed enzymatically *in vivo*.<sup>45</sup> Though the exact mechanism of its action is uncertain it appears that BAPN functions by interfering with collagen formation; this property is useful as a convenient assay method employing amphibian larvae.<sup>46</sup>

It has been suggested that the toxic nature of  $\alpha\gamma$ -diamino-butyric acid arises from its capacity to act as an antimetabolite to its higher homologues, ornithine and lysine.<sup>47</sup> Since  $\beta$ -aminoalanine also is a lower homologue of these amino-acids it could function as an antagonist to them. This compound has been reported to inhibit the growth of *Corynebacterium diphtheriae*<sup>48</sup> however, only  $\beta$ -oxalylamino alanine is neurotoxic to chicks and  $\beta$ -aminoalanine<sup>49</sup> and oxalic acid<sup>33</sup> are not. Recent studies using  $\alpha\gamma$ -diaminobutyric acid-2- $\text{C}^{14}$  in rats have shown that oxidation takes place at the  $\alpha$  or

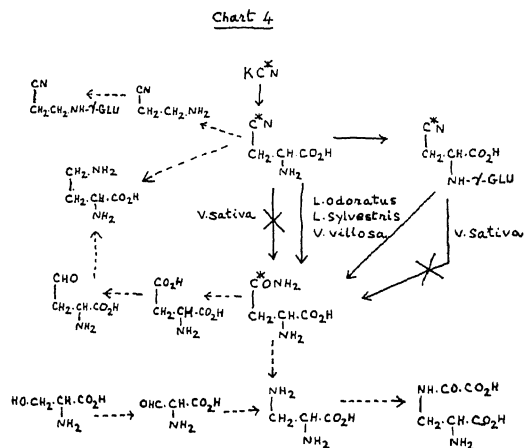
the  $\gamma$  carbon atom with the formation of  $\beta$ -alanine, aspartic acid and carbon dioxide<sup>49</sup>; this may indicate a possible method of detoxification. No information is yet available about the mode of action of the neurolathrogenic compounds present in the *Lathyrus* and the *Vicia* species. However, it is important to note that, while BAPN and its  $\gamma$  glutamyl derivative are osteolathrogenic, their carboxy derivatives, viz.,  $\beta$ -cyanoalanine and  $\gamma$ -glutamyl- $\beta$ -cyanoalanine have neurotoxic properties. It thus appears that the carboxyl group has an important role in determining the nature of the toxicity and one type may change into another by decarboxylation or carboxylation. This may explain how both types of toxicity may occur together.

$\beta$ -Aminoalanine and its derivatives seem to be widely distributed; it was previously known as a component of the antitubercular antibiotic, viomycin, produced by *Streptomyces puniceus* and *S. floridæ*.<sup>50</sup> A simple derivative of  $\beta$ -aminoalanine, albizzine ( $\beta$ -ureidoalanine) (XX), occurs in a number of *Mimosaceæ*<sup>51</sup>; its physiological properties are not known. Other amino-acids which have a formal structural resemblance to  $\beta$ -aminoalanine are willardine (XXI) present in the seeds of the *Acacia* species<sup>52</sup> and mimosine (XXII) occurring in *Mimosa pudica*, *M. palmeri* and *Leucaena glauca*.<sup>53</sup> The leaves of *L. glauca* ('koa haole') are a popular livestock feed in Hawaii islands but the animals become ill. The toxicity has been traced to the presence of mimosine.<sup>54</sup> Robinson pointed out the structural similarity of mimosine to DOPA and pyridoxine and cited experiments reporting its growth-inhibitory action in rats.<sup>55</sup>

The mode of biosynthesis of the *Lathyrus* and the *Vicia* compounds is a subject of current investigation. Inorganic cyanide is an excellent precursor for asparagine in the seedlings of *L. odoratus*, *L. sylvestris*, *V. villosa*<sup>43</sup> and other plants<sup>56</sup>;  $\beta$ -cyanoalanine and/or  $\gamma$ -glutamyl- $\beta$ -cyanoalanine are intermediates in this process. However, in *V. sativa* cyanide is incorporated into  $\beta$ -cyanoalanine and  $\gamma$ -glutamyl- $\beta$ -cyanoalanine but very little into asparagine. It appears that in the latter plant some step subsequent to the formation of  $\beta$ -cyanoalanine or the dipeptide is either blocked or absent resulting in the accumulation of the toxic products<sup>43</sup> (Chart 4).

In an earlier publication Ressler *et al.*<sup>56</sup> suggested what might be considered to be the reverse course of reactions for the formation of BAPS,  $\beta$ -cyanoalanine and  $\alpha$ - $\gamma$ -diaminobutyric

acid from asparagine. Murti *et al.*<sup>53</sup> pointed out that asparagine could also serve as a precursor for  $\beta$ -aminoalanine which can later undergo oxalylolation to  $\beta$ -oxalylamino alanine. An alternative route to  $\beta$ -aminoalanine could be by a transamination reaction involving serine aldehyde similar to the formation of ornithine from glutamic acid  $\gamma$ -semialdehyde<sup>57</sup>; serine occurs in high concentrations in *L. sativus* seeds.<sup>58</sup> An analogous scheme for the biosynthesis of  $\alpha$ - $\gamma$ -diaminobutyric acid from aspartic acid  $\beta$ -semialdehyde has been suggested<sup>49</sup> (Chart 4).



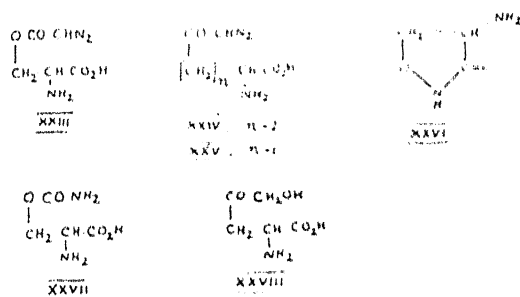
#### AMINO-ACIDS WITH ANTITUMOUR AND ANTITUBERCULAR ACTIVITY

Two naturally occurring amino-acids are known which possess the rare diazo group and have antitumour properties. These are azaserine (XXIII) and 6-diazo-5-oxo-norleucine (DON) (XXIV) which were isolated from the culture filtrates of strains of *Streptomyces*.<sup>59,60</sup> Both compounds produce a variety of biological effects; they inhibit microbial growth, induce abnormalities in embryonic development and, at sufficiently high dose levels, cause death.<sup>61</sup> Their striking tumour-inhibiting properties raised hopes that these substances may be useful in the control of cancer in the humans; however, they are too toxic for this purpose. Both azaserine and DON act as glutamine antagonists and inhibit purine biosynthesis.<sup>62</sup> The lower homologue of DON, 5-diazo-4-oxo-norvaline (XXV) has been synthesized and it also has antitumour action.<sup>63</sup>

The broad spectrum antibiotic, cycloserine (oxamycin) (XXVI), isolated from the soil

organism *Streptomyces incubus* is structurally closely related to serine and possesses the unusual 3-isoxazolidone ring.<sup>60</sup> The interesting biological properties have led to the synthesis of a number of structural analogues for the study of biological activity.<sup>61,62</sup> O-Carbamyl-D-serine (XXVII) is another derivative of serine obtained from a *Streptomyces*, but it has no antibiotic action.<sup>63</sup> Recently another new amino acid, 5-hydroxy-2-oxo-norvaline (HON, XXVIII), having antifibrotic properties, was isolated from *S. albobacillus*.<sup>64,65</sup> Analogues of this amino acid have been prepared and tested.<sup>66</sup>

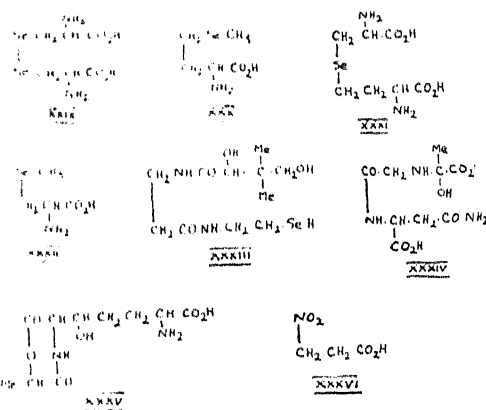
Chart 5



#### SELENIUM-CONTAINING AMINO ACIDS

Certain selenium analogues of sulphur amino acids occur in plants grown on selenium-rich soils. Selenocysteine (XXXIII) and selenomethionine (XXX) are identical chromatographically in maize, wheat and *A. trivittatus*,<sup>67</sup> and selenocystathionine (XXXII) has been isolated from *A. paspalis* and from the protein of a porcupine which grows on selenium-containing soil.<sup>68</sup> The selenium analogue of β-methyl cysteine (XXXII) occurs in *A. breutilifera*.<sup>69</sup> While ingestion of excess amounts of selenium is harmful trace quantities of this element are nutritionally essential. Absence of selenium causes exudative diathesis in chicks, nutritional myopathy (stiff limb disease or white muscle disease) in lambs and nutritional muscular dystrophy in other animals. These could be prevented or cured by selenium compounds or selenium-containing amino acids; though, in some cases, vitamin E is also necessary.<sup>70</sup> It is also of interest that in *E. coli* methionine is replaceable by its selenium analogue<sup>71</sup> and that selenopantetheine (XXXIII) is functional in *Lactobacillus helveticus*.<sup>72</sup> Studies with S<sup>35</sup> and Se<sup>75</sup> have shown that the selenium amino acids are not biosynthesized from sulphur analogues by mere replacement of sulphur by selenium but are produced independently.<sup>73,74</sup>

Chart 6



#### PHYTOTOXIC AMINO-ACIDS

The toxins of *Fusarium lycopersici* and of *Pseudomonas tabaci* have been shown to be amino-acid derivatives. The substance produced by *Fusarium* is lycopersamine (XXXIV)<sup>80</sup> which causes withering of tomato leaves. The toxin of *Pseudomonas* is tabtoxinine which is responsible for the wildfire disease of tobacco; it is a specific antagonist of methionine. Woolley *et al.*<sup>81</sup> have shown that tabtoxinine is most probably the lactone of α-lactylamino-β-hydroxy-γ-amino pinelic acid (XXXV).

#### β-NITROPROPIONIC ACID

Though not an amino-acid β-nitropropionic acid (XXXVI) is a close structural analogue of β-alanine, a component of coenzyme A and pantothenic acid. This interesting substance, containing the unusual nitro group, occurs in many sources.<sup>82</sup> It is the chief toxic constituent of the leaves of the forage plant *Indigofera endecaphylla*<sup>83</sup> (creeping indigo) in which it is present free and also as esters with glucose (endecaphyllins).<sup>84</sup> It produces nervous involvement in chicks leading to inability to stand, retraction of the head and lack of co-ordination; however, it is not toxic to rabbits or mice. Birch *et al.* found that aspartic acid is incorporated as a unit into β-nitropropionic acid by *Penicillium atrovenetum*.<sup>85</sup> No information is available as to how the amino group is oxidised to the nitro group; but compounds like aspergillie acid, mycobactin and mycelianamide are known in which the oxidation level of the amide nitrogen is that of hydroxylamine.<sup>87</sup>

The study of the free or non-protein amino-acids is typically a development of recent years; it has not only opened up a new field of natural

products but also created new possibilities. They are large in number, have members possessing novel features and some are markedly toxic to animals and plants. Their biogenesis and function in plants are subjects of great interest. The question of using their occurrence for taxonomical purposes is also attractive. A systematic study of these compounds holds the promise of leading to the development of new drugs. More important to food science is their possible antimetabolite action and hence there is need for a special programme of study of this aspect of the free amino-acids of plants. Their potency will be greater because of their solubility in water and the readiness with which they can be assimilated. This property of solubility in water can also be conveniently used for the removal of harmful amino-acids from foodstuffs.

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## AN OUTBREAK OF RABIES IN HORSES NEAR POONA, INDIA

KHORSHED M. PAVRI,\* C. R. ANDERSON\*\* AND K. R. P. SINGH\*

Virus Research Centre, Poona, India†

**R**ABIES is common in India in humans and dogs, and sporadic cases have been reported in cattle, cats and occasionally in horses. An outbreak involving animals on a single farm and without any history of bites is, however, unusual.

Between January and April 1962, at almost monthly intervals, four proven cases of rabies occurred in horses on a stud farm near Poona. Although the clinical course in these cases varied in duration from seven hours to six days, there was considerable similarity in the clinical signs. According to the details supplied by the management of the farm, the onset was abrupt, with the horses "going off feed" and appearing listless and feverish. There followed a period of restlessness, during which the horses pawed the floor and walked aimlessly about the stall, sometimes standing or lying down for short intervals. Three of the horses had difficulty with micturition. Other signs developed during

this time were twitching of the lip or muscles of the neck and shoulder, "patchy" sweating and hyperesthesia. Fever persisted throughout the illness. The temperatures ranged between 102° and 104° F. only occasionally and briefly falling to a lower level. Shortly before death, two of the horses became uncontrollable and would not permit the approach of a human. Death occurred in all cases during a convulsion.

The Virus Research Centre was requested to investigate the cases. As an arthropod-borne viral encephalitis was a possibility, attempts were made to collect mosquitoes and ticks. Owing to dry weather very few mosquitoes were obtained. Only the horse tick *Otobius megnini* was found on horses, and no virus was isolated from pools of this tick.

Post-mortem specimens of brain, liver, spleen, lungs and kidney were submitted from the four cases and attempts to isolate virus were made in mice. A strain of virus identified by neutralization test as rabies was isolated from the brain of each horse.

During the interval four other horses died on the stud. The clinical signs in these cases were not strikingly different from those in the first four. Organs from one of the horses in this second group were processed for virus isolation

\* Research Officer, Virus Research Centre, Poona, India.

\*\* Staff Member, The Rockefeller Foundation, Virus Research Centre, Poona.

† The Virus Research Centre, is jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation.

attempts, but no agent was recovered. No organs were submitted from the other three horses.

It is known that neurological manifestations in large animals may not be typical of rabies and that therefore a clinical diagnosis may not be possible. This has been reported in a description of an outbreak in cattle.<sup>1</sup>

The stud farm, which is devoted to the breeding of race horses, covers an area of 320 acres, 75 acres of which are usually under cultivation to lucerne (with sugarcane in water-logged places) during the monsoon. At the time of the outbreak the farm had 220 animals. In addition to the manager and a full-time veterinarian, there is a large auxiliary staff. None of the people associated with the cases reported any history of obvious wounds or bite marks on the horses for a period of six to eight months before the onset of illness. Furthermore, a daily medical register is kept of all injuries, small or large, and all illnesses. Since it seems unlikely that four horses could be infected by the commonest carnivores without there being evidence of the attack, the fox, the jackal and the stray dog have been excluded from consideration as vectors in this outbreak.

The possibility exists of bite by smaller mammals such as the mongoose and the bat. The Indian mongoose has been reported to be a very important reservoir of rabies in Puerto Rico,<sup>2</sup> and rabies due to mongoose bite has been reported in India.<sup>3</sup> In the Americas, several genera of bats have been found to transmit rabies by bite. A recent report also suggests

that rabies associated with bats may be acquired by a mechanism other than bite.<sup>4</sup> So far, only one case of possible bat rabies has been reported in India.<sup>5</sup> No evidence of attack of the stud farm horses or history of anomalous behaviour in either bats or mongooses was elicited.

Subsequently, several of the farm animals other than horses died of rabies. Since these animals had not been observed as carefully as the horses, the absence of any history of bites in their cases is not of the same significance. The pertinent details concerning these animals are as follows:

**Bullock.**—Died on August 8, 1962, after two days of illness. The brain was sent to the Haffkine Institute which reported negri bodies in smear.

**Dog.**—Died on October 17, 1962, after two days of illness. Rabies virus was isolated from the brain.

**Mule.**—Died on December 28, 1962, after four days of illness. Rabies virus was isolated from the brain.

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## APOMIXIS IN GYMNOSPERM

T. N. KHOSHOO

Post-Graduate Department of Botany, Jammu and Kashmir University, Naseem Bagh, Srinagar  
Kashmir, India

A REASONABLY clear picture exists of the various cytogenetical factors underlying evolution in angiosperms and pteridophytes. The gymnosperms, on the other hand, have just begun to receive attention from this aspect. We have now estimates of the role of gene mutations, hybridization, karyotypic alterations and polyploidy in the gymnosperms.<sup>1</sup> The role of apomixis in the evolution of gymnosperms is brought out in the present paper.

Following the classification of Gustafsson,<sup>2</sup> apomixis is distinguished in the first instance into vegetative reproduction and agamospermy. Strictly speaking, the vegetative reproduction in gymnosperms is known only in some cycads and *Ephedra*. However, there are doubtful reports of the occurrence of agamospermy in three species, namely *Ginkgo biloba*,<sup>3</sup> *Pinus pinaster*<sup>4</sup> and *Pseudotsuga menziesii*.<sup>5,6</sup> In these species agamospermy does not occur as a normal rule,



but has been suspected to occur in unpollinated cones. The probable mechanism involved, as believed by some of these workers, is adventive embryony or, what is more plausible, the fertilization of the egg nucleus by the ventral canal nucleus. Suggestions have been made from time to time regarding the occurrence of this type of fertilization in gymnosperms.<sup>7-9</sup> However, the fact remains that even though gymnosperms are well worked out embryologically, there is no species where agamospermy of any type has been found as a normal and a regular feature. This, indeed, is a significant point. The following explanation is suggested for the absence of this process in gymnosperms.

Apomixis in any form is elimination of meiosis; more exactly, it is the elimination of the genetical differences that result as a consequence of meiosis. In simpler words apomixis means perpetuation of constancy in genotypes. Whether genetic uniformity is needed, or, whether it is compatible with the other traits of the genetic system, is, therefore, the real question.

Most important among the gymnosperms are the conifers. These though few in number in comparison to angiosperms, however, dominate the temperate regions of the world forming climax vegetation in practically stable habitats. The species are mostly monoecious with unisexual cones but some are also dioecious. In either case the plants are out-crossed by wind pollination. It is a matter of common knowledge that forest stands in these regions are heterozygous. In fact forest tree breeders in the temperate regions make "genetic improvement on the lines which approach conditions in organic evolution".<sup>10</sup> It would be extremely hazardous to have homozygous forest stands because it would mean either all-out survival or all-out extinction against any calamity like fungus or insect attack. The reproductive need both in nature and in silviculture is to have large heterozygous progeny from which most fit individuals are selected and constitutes the climax forest. As such the genetic system in gymnosperms (out-crossing, relatively high chromosome number and chiasmata frequency, and low intersterility) promotes variability of which considerable amount is stored.

Conifers form more or less closed communities, and it is commonly observed that for any niche opened by the death of an old tree there are very many competitors. Since the seed is produced after cross-pollination there are likely to be genic differences among the seedlings. Thus, there is always a chance that the one with the best genotype will be selected and will replace the lost individual. Therefore, evolutionary processes promoting constancy, like self-pollination and apomixis, do not have a selective value, because these will give only temporary genetic advantage which is not needed for the long-lived plants like conifers in which replacement of generations is very slow. Right type of "biological capital" has to be chosen before it is "locked up" for many years to come. Under these circumstances flexibility cannot be sacrificed for immediate fitness endowed by a process like apomixis. On the other hand, self-pollination and apomixis are likely to have better chances of occurrence in groups of plants which occupy temporary habitats whose populations fluctuate in sizes. Because, the advantage will go to those that can build up rapidly sizable populations of "largest number of highly adapted descendants".<sup>11</sup>

In conclusion it may be emphasized that the phenomena promoting genetic constancy like apomixis are incompatible with the genetic-evolutionary needs of a group like gymnosperms in which individuals are long-lived and slow-growing perennials.

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## LETTERS TO THE EDITOR

PREPARATION OF DI-CAESIUM  
URANYL-NITRATE,  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ 

In the course of studies on the effect of reactor radiations on the spectrum of  $\text{UO}_2^{++}$  reference to literature showed that in the case of alkali metal uranyl-nitrates, examples of di-alkali uranyl-nitrates are known for rubidium and potassium. Attempts to prepare the di-caesium salt however do not seem to have been successful.<sup>1</sup> Spectroscopic results of reactor irradiated  $\text{CsUO}_2(\text{NO}_3)_3$  indicated that the spectrum of the irradiated salt might be identical with that of di-caesium salt. It was therefore thought necessary to try to prepare the di-caesium uranyl nitrate chemically. This has been done and briefly reported.<sup>2</sup> A further detailed report appears to be called for and is given below.

Cæsium nitrate (BDH Analar) and uranyl-nitrate hexa-hydrate are mixed together, always taking care to see that a little excess of  $\text{CsNO}_3$  over that required to give the di-caesium uranyl-nitrate salt, is present. This is necessary to avoid formation of small amounts of mono-caesium-uranyl-nitrate. The pH of the solution is kept at about '2'. The solution is evaporated to dryness over a water-bath. The dissolution and evaporation is repeated four or five times until the pH is about '3'. The saturated solution is then quickly cooled to room temperature ( $28^\circ\text{C}$ .) and immediately transferred to a desiccator maintained at about  $10^\circ\text{C}$ . Yellowish-green crystals of  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$  start separating out in about a week.

With uranyl-nitrate-tri-hydrate as starting material it is found that the number of dissolutions and evaporation processes can be reduced. The crystals obtained by slow crystallisation at  $10^\circ\text{C}$ . are about a millimeter in cross-section.

Micro-crystalline powder of the di-salt can be obtained as follows. Stoichiometric amounts of  $\text{CsNO}_3$  and  $\text{UO}_2(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$  are dissolved in distilled water and evaporated to dryness on water-bath. The residue on dissolution and evaporation over a sand-bath leaves a micro-crystalline substance. The identity of this micro-crystalline powder with the crystals formed by slow evaporation at  $10^\circ\text{C}$ . is established by fluorescence spectra.

That the compound prepared in these experiments is a definite chemical compound  $[\text{Cs}_2\text{UO}_2$

$(\text{NO}_3)_4]$  and not a mixture of the individual components  $\text{CsUO}_2(\text{NO}_3)_3$ ,  $\text{UO}_2(\text{NO}_3)_2$  and  $\text{CsNO}_3$  is supported by the following facts.

1. Chemical analysis of the crystals isolated from mother liquor in different independent preparations give the following results:—

TABLE I

	Analysed value	Expected value for $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$
Cs	33.6%	33.88%
U	29.2%	30.38%
$\text{H}_2\text{O}$	Nil	Nil

The fact that there is no water of crystallisation clearly shows the absence of any free uranyl-nitrate-hydrates.

2. The yellowish-green colour of  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$  crystals is different from the colours of  $\text{CsUO}_2(\text{NO}_3)_3$  or  $\text{UO}_2(\text{NO}_3)_2$ , tri- or hexa-hydrate.

3. The fluorescence spectrum of this salt has been recorded and reported<sup>2</sup> at  $77^\circ\text{K}$ . and analysed in detail.<sup>3</sup> The analysis clearly indicates the similarity of the spectrum with the corresponding spectra of  $\text{Rb}_2\text{UO}_2(\text{NO}_3)_4$  and  $\text{K}_2\text{UO}_2(\text{NO}_3)_4$  salts. There is no trace of the well-known fluorescence bands of  $\text{CsUO}_2(\text{NO}_3)_3$  or  $\text{UO}_2(\text{NO}_3)_2$ , tri- or hexa-hydrate spectra in the spectrum of the di-caesium salt.

4. The infra-red spectra of  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ ,  $\text{CsNO}_2(\text{NO}_3)_3$  and  $\text{CsNO}_3$  have been taken as mulls.  $\text{CsNO}_3$  shows an intense and broad absorption at about  $1350\text{ cm}^{-1}$  corresponding to the anti-symmetric frequency of  $\text{NO}_3^-$ . This absorption is completely absent in  $\text{CsUO}_2(\text{NO}_3)_3$  and  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ , showing thereby that these substances do not contain free  $\text{CsNO}_3$ . Instead of the  $1350\text{ cm}^{-1}$  absorption,  $\text{CsUO}_2(\text{NO}_3)_3$  shows two absorption bands of almost equal intensity at  $1264\text{ cm}^{-1}$  and  $1520\text{ cm}^{-1}$ .  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$ , on the other hand, shows absorption at  $1264\text{ cm}^{-1}$  and  $1485\text{ cm}^{-1}$ .

5. The X-ray diffraction pattern of  $\text{Cs}_2\text{UO}_2(\text{NO}_3)_4$  is distinctly different from that of the mono-caesium salt and is similar to that of the di-rubidium salt indicating that it is isomorphous with the di-rubidium salt.

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Division of Spectroscopy, R. K. ASUNDI.  
Atomic Energy Establishment, R. M. DIXIT.  
Trombay,  
414 A, Cadell Road,  
Bombay 28, April 29, 1964.

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### ON THE INVESTIGATION OF 'Z' DEPENDENCE OF RAYLEIGH SCATTERING OF GAMMA-RAYS

Our earlier measurements<sup>1,2</sup> on the Rayleigh scattering of 662 keV. gamma-rays from different elements could yield the values of the index to the power of 'Z' only over limited ranges (1.1 to 2.4 and .08 to .26) of momentum transfer ( $q = 2h\nu/m_0c^2 \sin \theta/2$ ) involved in the scattering process. This limitation was experienced because with gamma-rays of energy 662 keV. it was possible to measure cross-section with a reasonable accuracy only at angles less than 15° and greater than 40°. In the angular range 15° to 40° the energy of coherent scattering is not much different from that of incoherent scattering so it is difficult to measure its contribution with any significant accuracy. A major part of the gap in the momentum transfer (from 2.26 to 1.1) has been filled by studying the scattering of 280 keV. gamma-rays through angles greater than 75° where coherent scattering can be easily separated from the incoherent scattering energetically. The method of measurement was the same as used earlier. Gamma-rays of 280 keV. were obtained from a Hg-203 source. The results are given in Table I, which give the cross-section and the values of the index to the power of 'Z' at various scattering angles.

The variation of the index to the power of 'Z' with momentum transfer is compared with the available theoretical calculations<sup>3,4</sup> in Fig. 1. Some of the experimental points have been calculated from the data of other workers.<sup>5,6</sup> The results clearly contradict the  $Z^3$  dependence as predicted by the non-relativistic form factor calculations of Franz. The theoretical curve calculated from Bethe's form factor as given by

TABLE I

Scattering Angle	Differential scattering cross-section in $10^{-27} \text{ cm}^2 \text{ per sterad}$					Index to the power of Z
	Pb	W	Sn	Ag	Mo	
(90±5)°	45.6 ±1.5	31.2 ±1.2	9.42 ±.40	7.43 ±.35	4.49 ±.33	3.3 ±.1
(105±5)°	41.4 ±1.5	32.2 ±1.0	8.25 ±.24	6.28 ±.25	3.17 ±.22	3.6 ±.1
(120±5)°	42.2 ±1.5	32.3 ±1.0	6.97 ±.20	5.17 ±.20	2.72 ±.22	3.8 ±.1
(135±5)°	43.3 ±1.6	32.9 ±1.0	6.35 ±.20	4.85 ±.20	2.53 ±.20	4.0 ±.1
(150±5)°	45.4 ±1.6	34.3 ±1.0	6.65 ±.25	4.71 ±.20	2.24 ±.16	4.1 ±.1

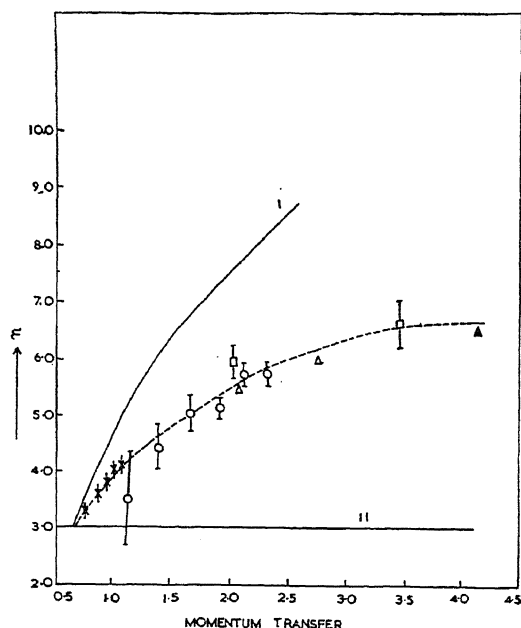


FIG. 1. Variation of the index ( $n$ ) to the power of Z with momentum transfer. Curve I calculated from Bethe's form factor; Curve II from the Franz's form factor— — — experimental curve, x experimental points for 280 keV. O for 662 keV. and □ from reference 5 and Δ from reference 6.

Levinger is higher than the experimental curve; the difference is greater when the momentum transfer is higher. In the absence of any reliable straightforward theoretical calculations, the experimental curve of Fig. 1 along with the existing experimental data on cross-sections and the theoretical data of Brown's<sup>7</sup> refined calculations for scattering from Hg may be used to make a reliable estimate of Rayleigh cross-section for any element,

Physics Department,  
Panjab University,  
Chandigarh-3, March 23, 1964.

S. ANAND.  
M. SINGH.  
B. S. SOOD.

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### POLYPHENOLIC COMPONENTS OF GUAVA FRUITS

In an earlier note<sup>1</sup> was mentioned that the ripe fruits of guava contain ellagic acid. In order to get more information about the formation of this acid, we have now examined the fruits at three different stages of ripening, separating the juice and pulp: (1) unripe (3 weeks old), (2) half ripe (6 weeks old) and (3) fully ripe but not overripe. The juice of (1) was found to yield considerable amounts of soluble and insoluble oxalates. Sodium, potassium and calcium metals were found to be present. Small amounts of soluble chlorides and sulphates of these metals also were detected. The juice of (2) contained only soluble oxalates in lesser quantities as compared to (1), while (3) contained none at all. Glucose, maltose and arabinose were detected as free sugars and their amounts increased with ripening.

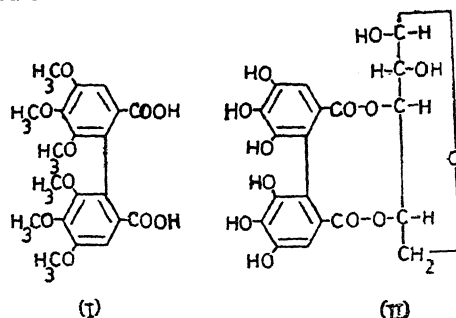
The pulp from (1) was extracted with ethanol and fractionated into (a) light petroleum soluble, (b) ether soluble and (c) ethyl acetate soluble fractions. Fraction (a) contained chlorophyll, waxy matter and carotenoids. Fraction (b) contained small amounts of quercetin, its 3-arabopyranoside guajaverin, gallic and ellagic acids as well as trace amounts of a sugar ester of ellagic acid (E) described below. These compounds were detected by paper chromatography, colour tests and comparison with authentic samples. Fraction (c) gave leucocyanidin in 0.1% yield, along with small amounts of (E).

From the residual aqueous alcoholic mother liquor the sugar ester (E) was obtained in 0.1% yield. It was freed from the accompanying free sugars and pectins by making its lead salt and decomposing it with hydrogen sulphide. The mineral matter was removed by passing its solution through a mixed-bed ion-exchange column. Thus it was obtained as colourless

small plates, m.p. 230–35° (decomp.),  $[\alpha]_D^{25}$ , –24.2 (pyridine).

This sugar ester (E) gave one mole of ellagic acid per mole of L-arabinose by acid and alkali hydrolysis. This indicated that it was an ester of hexahydroxydiphenic acid with L-arabinose in 1:1 proportion. The elemental analysis of (E) as well as of its acetate and the quantitative alkali hydrolysis of the latter were in agreement with the above conclusion. The  $\lambda_{\max}$  at 272 m $\mu$  and a definite ester band at 1740 cm.<sup>-1</sup> in the I.R. spectrum further confirmed its being an ester rather than a O-glycoside. Methylation of the sugar ester with diazomethane and hydrolysis of the methyl ether gave hexamethoxydiphenic acid (I) which is obtained here in its laevorotatory form. From myrobalan tannins this acid is obtained in its dextrorotatory while other ellagitannins yield its laevorotatory form. The arabinose ester as well as its hexamethyl ether gave brownish-purple rings on circular paper chromatograms when sprayed with aniline hydrogen phthalate, a specific reagent for potential aldehyde group.<sup>2</sup> Further the above methyl ether reduced Fehling's solution. These two tests indicated that the reducing group in the sugar moiety is free. The presence of one glycol unit in the molecule was shown by qualitative and quantitative reaction with periodic acid. Hence one mole of hexahydroxydiphenic acid is attached to one mole of arabinose at carbon atoms 3 and 4 by ester linkages, on the assumption that the sugar is in the pyranose form. Hence the structure (II) has been assigned to it as the most probable; experiments to establish the nature of the ring structure of the arabinose moiety are still in progress.

This is the first case so far reported in ellagitannins where L-arabinose forms the carbohydrate core.



In the pulp of (2) quercetin, guajaverin and gallic acid were found in traces while free ellagic acid was present in better yields. The

amount of the arabinose ester, however, decreased considerably. In pulp (3) no arabinose ester was detected, only free ellagic acid was present but in slightly lesser quantities than in (2). The sugar ester seems to get hydrolysed to L-arabinose and ellagic acid during the ripening process. The red pulp of the fruits contains more of ellagic acid (0.2%) than the white one (0.05%).

Frequently the skins of apple guavas are red in colour and they have now been found to contain a cyanidin diglucoside which appears to be mecocyanin. Leucocyanidin is present as a constituent of the fruits in all stages although in highest yields in the unripe fruits, while in the ripe ones it is more concentrated on the skin and seeds.

We convey our thanks to C.S.I.R. for the grant of fellowship to K. V.

Department of Chemistry, T. R. SESHADRI.  
Delhi University, (Miss) K. VASISHTA.  
April 11, 1964.

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#### AMINO-ACID UTILIZATION BY ICRC BACILLI ISOLATED FROM HUMAN LEPROMATOUS TISSUES

IN our laboratory, a strain of acid fast mycobacterium designated as 'ICRC bacillus' has been isolated from human lepromatous leprosy nodules. As has been already reported,<sup>1</sup> it is possible to cultivate these mycobacteria on basic tissue culture medium (Eagle's medium<sup>2</sup> + horse serum) used by stock cells in continuous cultivation designated here as 'conditioned fluid'. It was also observed from these studies that the mycobacteria cannot grow on a mixture of Eagle's medium<sup>2</sup> and human serum, unless the same is preconditioned by the growth of human cells in it. It was thought possible that the bacilli, besides using the constituents present in the mixture, also require a product or products of the cell metabolism. This prompted us to study the metabolism of ICRC bacilli with reference to requirements of amino-acids which are constituents of Eagle's medium as well as human serum.

These studies were carried out on bacilli which had been in cultivation for nearly one year. As a procedure, the bacilli were allowed

to grow in conditioned fluids for only 15 days so as to ensure that they were in logarithmic phase of growth at the time they were taken for study. Standard inoculum size and standard volume was used for all the experiments. The conditioned fluid, in which the bacilli have been grown for specific time, was made free from bacilli and analysed qualitatively by chromatography and quantitatively using microbiological procedures. For chromatography, the fluid was concentrated under vacuum and then dissolved in distilled water. The solutions were directly used for chromatography without desalting.

The technique used was similar to that of Paseika *et al.*<sup>3</sup> A solvent system of *n*-butanol acetic acid-water mixture was used. 0.2% ninhydrin solution in 80% alcohol was used for detecting the spots. The results can be seen from Fig. 1. It is evident that

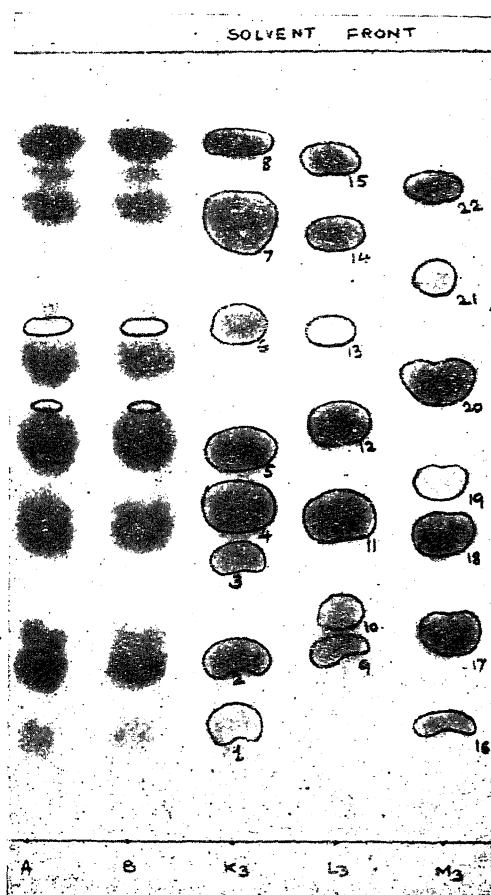


FIG. 1. Changes in amino-acid composition of "conditioned fluid" during cultivation of ICRC bacilli. A, Control conditioned fluid; B, Conditioned fluid after growth of bacilli; K<sub>3</sub>, L<sub>3</sub>, M<sub>3</sub>. Amino-acid mixtures,

qualitatively there is no change in the number as well as density of the ninhydrin positive spots due to amino-acids and peptides present in the fluid even after growth of bacilli in it.

The microbiological analysis was carried out on fluids from which proteins had been separated by precipitation with trichloroacetic acid. The amino-acids were estimated by the standard procedures recommended by Barton-Wright.<sup>4</sup> The results are presented in Table I.

TABLE I  
*Amino-acids in experimental fluids*

Amino-acid	Conditioned fluid mcg./c.c.	Conditioned fluid after growth of bacilli. mcg./cc.
Arginine	9.32	9.57
Threonine	7.47	7.83
Leucine	2.04	1.79
Isoleucine	6.16	4.00
Valine	2.64	3.15
Lysine	9.30	7.20
Phenylalanine	12.70	9.40
Histidine	2.70	2.10

The results of Table I show that the growth of bacilli in conditioned fluids for nearly fifteen days, during which time the bacilli have multiplied nearly four times, has practically no significant effect on the amino-acid composition of the medium.

The results of the chromatographic as well as microbiological analysis point out that ICRC bacilli use very little of amino-acids and peptides present in conditioned fluids. This is in support of earlier observation<sup>1</sup> that the bacilli cannot survive in Eagle's medium supplemented with human serum, both of which are rich sources of amino-acids. It is possible that the bacilli do not depend upon such components as amino-acids and may be utilizing some of the metabolic products of cell growth for their survival and multiplication.

Applied Biology Group, B. N. MASHELKAR.  
Indian Cancer Res. Centre, A. V. BHAT.  
Parel, Bombay-12, April 4, 1964.

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### (±) LEUCOCYANIDIN FROM THE SEEDCOAT OF *CALOPHYLLUM INOPHYLLUM* LINN.

SESHADRI AND CO-WORKERS<sup>1,2</sup> have reported on the varying physical characteristics of leucocyanidin and its derivatives obtained from different sources, the latest being *Psidium guajava*.<sup>3</sup> During the course of our work on the survey of flavonoids in South Indian plants, we have chemically examined the (somewhat) hard testa of the seeds of *Calophyllum inophyllum*<sup>4</sup> growing in Pondicherry and the isolation of (±) leucocyanidin is briefly reported.

The dried testa in coarse powder form was first extracted with peroxide-free ether and then with acetone by cold maceration three times, each time lasting for 4 hours. The ether concentrate answered tests for the presence of a small amount of sterol.

The acetone extract was concentrated under reduced pressure and the brown viscous residue was taken up in dry ethyl acetate and to the clear solution, petroleum ether (40–60°) was added in stages to remove some brown impurity at the beginning and then to precipitate the leucoanthocyanidin as a light brown solid. This was re-dissolved in ethyl acetate and precipitated twice by means of petroleum ether, when colourless tiny needles sintering at 210° and not melting below 320° were obtained: yield, 0.3%. It gave a blue colour changing to greenish-blue with alcoholic ferric chloride and developed a deep pink colour when boiled with aqueous HCl, indicating that it was a leucoanthocyanidin. It gave a colourless acetate (acetic anhydride and pyridine), sintering at 225° and not melting below 320°, but on methylation (di-methylsulphate and potassium carbonate in anhydrous acetone medium) a colourless crystalline methyl ether, m.p. 217–18° was obtained. The compound, its acetate and methyl ether did not show any optical activity in ethyl acetate or methanol. The compound was converted into the corresponding anthocyanidin by boiling with 2N aqueous hydrochloric acid for 30 minutes; the anthocyanidin was identified as cyanidin by its absorption ( $\lambda$  max. 544 m $\mu$  ethanolic HCl) and R<sub>f</sub> values on paper chromatography and comparison with an authentic sample. The homogeneous character of the compound was also seen on paper chromatography, giving a single spot.

It may be mentioned here that different forms of leucocyanidin have been reported earlier from different sources and this appears to be the first report on the occurrence of (±) leucocyanidin,

giving an acetate and methyl ether exhibiting no optical activity. It is probable that the variation in the physical characteristics reported earlier may be due to the different proportions of (+) and (-) leucocyanidins and in this particular case, the two may be present in equal proportions.

We thank Prof. T. R. Seshadri for his kind interest in this work.

Medical College, A. G. R. NAIR.  
Pondicherry, S. SANKARA SUBRAMANIAN.  
February 19, 1964.

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#### OUTGROWTHS ON ZIRCONS FROM WARKALLI SANDSTONES, KERALA STATE

THIS communication records the rare occurrence of zircons with outgrowths from the sandstones of miocene age from Warkalli (Long. 76° 45' and Lat. 8° 45'). There is no reference regarding the zircons with outgrowths reported from India, excepting the one reported from Kamathi sandstones by Sripada Rao and Deshpande.<sup>1</sup> However, outgrowths from detrital grains of zircons have been reported from outside India by Butterfield,<sup>2</sup> from the Millstone grits of Yorkshire, Smithson,<sup>3</sup> from the jurassic beds of Yorkshire and Geoffrey Bond,<sup>4</sup> from Southern Rhodesia.

The note records the occurrence of detrital zircons on which the secondary growths have been seen. The zircons occur in the heavy mineral assemblage separated by bromoform from the Warkalli sandstones. The heavy crop comprises in the order of abundance, ilmenite, pyroxene, zircon, rutile, monazite, sillimanite apatite and garnet. In this connection, it is curious to note that there is an antipathy between zircons with outgrowths with monazite in its frequency.

Zircon is the prominent mineral and occurs in variegated forms. It occurs as both well-developed euhedral crystals with pyramidal terminations to fractured to rounded grains. They are coloured as well as colourless. There are zircons with inclusions and without inclusions. Most of the zircons are characterized by

zoning and display a black border. Sometimes the zircons are studded with innumerable inclusions as to render the grain dusky. The average grain size range from 0.4 mm.  $\times$  0.3 mm. to 0.03 mm.  $\times$  0.05 mm.

Outgrowths occur on grains, irrespective whether coloured or not and also whether zoned or rounded. They generally show a preference to prismatic crystals with pyramidal terminations. Nevertheless, they are also seen sporadically occurring on rounded grains and on pyramidal faces. In the case of rounded grains, the outgrowths are seen protruding pointedly. The outgrowths are seen securely attached to the main grain, and are in perfect optical continuity. Many of the grains to which outgrowths are attached show no trace of zoning and their sharp terminations are in strong contrast to the rounded outline of the supporting grain. The outgrowths are always clear and colourless and free from inclusions. In a few grains small corrugated outgrowths on prismatic crystals giving a sawfish appearance are seen (Fig. 1).

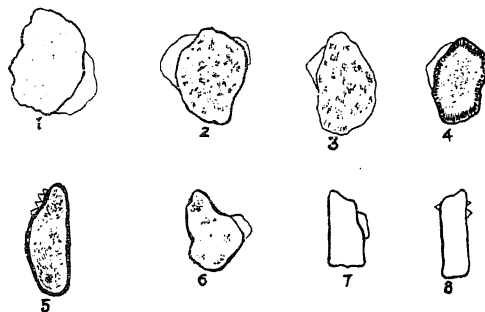


FIG. 1. Camera lucida drawings of outgrowths on zircon (varying magnification).

The outgrowths noticed in zircons of Warkalli sandstone throw much light on the nature of the sediments, as such outgrowths in zircon are reported from only non-marine sediments in literature. Smithson concludes "that zircons with outgrowths occur usually in deposits of either deltaic or nearly deltaic origin". The sharp terminations of the outgrowths in strong contrast to the rounded outline of the supporting grain indicates that the material whatever its composition is authigenic.

The mere fact that monazite is scarce in specimens characterized by zircons with outgrowths may lead one to doubt whether the secondary material occurring as outgrowth on zircon is not in fact zircon but some rare-earth isomorphous mineral derived by the decomposition of monazite and deposited on zircon as

outgrowth(?). The validity of the above statement can only be established by X-ray and spectroscopic study. The mere fact that the outgrowths are always colourless and free from inclusions, irrespective of the grain on which it is found, suggests that they were all formed under similar environmental conditions.

It is curious to note that the sands of Cape Comorin are also characterized by zircons with outgrowths, though not in abundance as compared to Warkalli sandstone. The author (Babu<sup>3</sup>) has drawn the conclusion in one of his earlier publications that the material constituting the Cape Comorin sands was derived from two sources, namely, igneous and sedimentary. The fact that zircons with outgrowths occur in Warkalli sandstone and also in Cape Comorin sands suggests that part of the material to Cape Comorin beach sand was contributed from Warkalli sandstone. Further the study of outgrowths of zircons in Warkalli sandstones indicates that the sediments are sub-aqueous and deltaic in nature.<sup>1-4</sup>

My thanks to Sri. Nair for providing the specimen from Warkalli.

Department of Applied Geology, S. K. BABU.  
University of Saugor,  
Saugor (M.P.), May 16, 1963.

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#### ON THE NATURE OF MICROFOSSILS IN BUKIT ASSAM LIGNITE INDONESIA\*

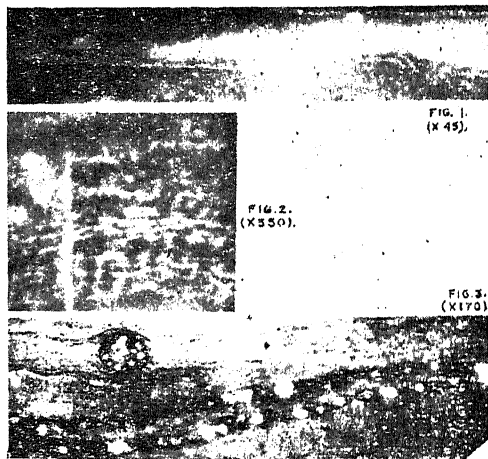
MICRO-STRUCTURAL details observed in thin section study of the Eocene lignite (para-lignite of Seyler's classification) from Bukit Assam Coalfield, Palembang District, South Sumatra, Indonesia, are described here, adopting the terminology advanced by the "Lignite Group" of the International Committee for Coal Petrology.<sup>1</sup>

The lignite shows micro-lamination and is composed dominantly of semi-detritinite, in which micro-structural details are not discernible. Thin layers, fragments and bands of xylinite alternate commonly and show dark-red resinite as cell-fillings. Bright yellow, thin cutinite, and deep yellowish, elongate or oval, homogeneous-appearing, melanoresinite are commonly seen in the matrix. Homocarbinite (massive micrinite) is rare.

The micro-fossils observed are included, on the basis of their origin, under the macerals suberinite, sclerotinite, sporinite and semifusinite. They are uncommon and exhibit well-preserved micro-structural details.

*Suberinite*.—Fractionated parts, fragments and layers of cork and suberised periderm. The cells are bright yellow, thin-walled, rectangular to brick-shaped, and serially-arranged indicating their secondary character. The intercellular cavity and middle lamella are not traceable. The cell lumen varies in size depending upon the compression undergone by the tissue and is invariably infilled by dark-red material resembling the matrix surrounding the cork tissue.

Figures 1 and 2 illustrate layers of cork tissues. Figure 2 exhibits under high power a thick layer in which cellular structure is clear in the lower portion, and becomes progressively indistinguishable upwards merging finally into the woody matrix. Cork tissues bordering semifusinite have also been observed.



FIGS. 1-3

Similar cork tissues have been recorded from the James coal of Middle Eocene age in New Zealand by Penseler,<sup>2</sup> who attributes their preservation to the "decay-resisting qualities of suberin, which is similar in composition to cutinite".

*Sclerotinite*.—The most common sclerotia species is *Sclerotites brandonianus*. *Sclerotites crassitesta* Starch, *Globosclerotes cegiranus*—textosclerotinite, *Sclerosporis bicellue*, and *Sclerosporis tricellus*—sporosclerotinite have also been observed and are markedly similar in nature to those recorded in the Palana lignite of India,<sup>3</sup> the teleutospore chambers, however,



do not show central opening. Tubular sporangia also occur and show thick-walled nature of the cells, being thus markedly distinct and different from those illustrated by Stach<sup>4</sup> in the Tertiary lignites of Cuddalore, India, and Böhlen, Germany.

**Sporinite.**—Microspores are common and appear as yellowish streaks. Some microspores are comparatively larger and are characterised by a thin dark-brown crenulated exine, and bright yellow sporogenous interior.

**Semifusinite.**—The Semifusinitised woody tissues are characterised by the very thick-walled nature of the cells and empty lumen.

Some micro-fossils, whose origin can be deciphered on systematic search of similar material in other Tertiary lignites, appear as chains of dark-brown or opaque, arc-shaped, conjoint segments (see Fig. 3). They occur either isolated or as cluster along the lamination.

The study indicates that the angiospermous wood, from which lignite is derived, was subjected to extensive decay and disintegration with the result that well-preserved wood is not traceable. The micro-fossils preserved are those that resisted decay due to concentration of higher proportions of chemically insoluble and resistant plant substances. The occurrence of sclerotia in conspicuous proportion indicates that favourable conditions of plant accumulation, deposition and decay existed for development of fungi.

Geological Survey of India, H. S. PAREEK.  
27, Chowringhee,  
Calcutta-13, February 29, 1964.

\* Published by kind permission of the Director-General, Geological Survey of India.

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# ON PRATYLENCHIDAE CRENICAUDA WINSLOW, 1958 (NEMATODA: PRATYLENCHINAE) FROM SRINAGAR (KASHMIR), INDIA

A LARGE number of females of *Pratylenchoides* Winslow, 1958, were found in soil from around roots of pomegranate, *Punica granatum* L., from Srinagar (Kashmir), India. Study of these worms revealed that they represent the type and the only species *Pratylenchoides crenicauda* Winslow, 1958. It is for the first time that this genus is being reported from India.

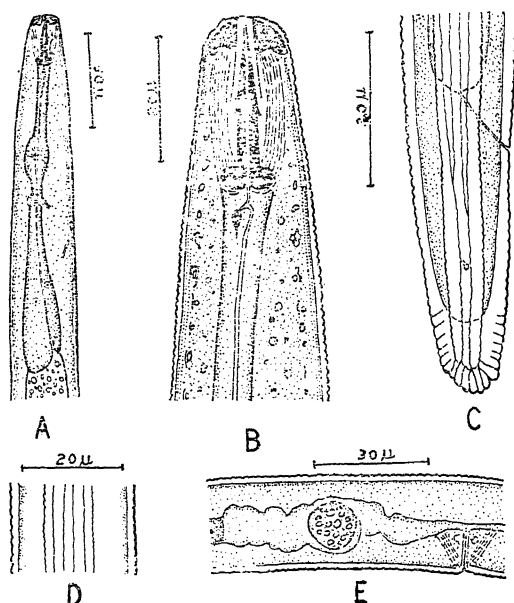


FIG. 1. A-E. *Pratylenchoides crenicauda* Winslow, 1958. A, Esophageal region; B, Head end; C, Tail showing fusion of incisures; D, Lateral field near middle of body; E, A portion of gonad showing spermatheca.

Description of *Pratylenchoides crenicauda* (= *Anguillulina obtusa*), as provided by T. Goodey,<sup>1,2</sup> Winslow<sup>4</sup> and Goodey and Goodey<sup>3</sup> is insufficient in regard to the characters of spermatheca and lateral fields. The present specimens as well as those obtained from Rothamsted Experimental Station, England, through the courtesy of Dr. J. B. Goodey, show definite spermatheca in both the reproductive branches near the junction of oviduct and uterus, although according to Goodey and Goodey<sup>3</sup> it is absent. Winslow<sup>4</sup> and Goodey<sup>1,2</sup> do not mention the lateral fields, although the latter author has shown four incisures on the tail. Goodey and Goodey<sup>3</sup> describe lateral fields with four incisures. The present study shows that the number of incisures in the lateral fields near the middle of body is 5 or 6 instead of 4. The inner ones fuse near the anal region (slightly above or below the latitude of anus) to form four distinctly crenate incisures which continue slightly above the tail tip.

Dept. of Zoology, M. SHAMIM JAIRAJPURI.  
Aligarh Muslim University,  
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# INCIDENCE OF THE COCONUT CATERPILLAR, *NEPHANTIS SERINOPA* MEYR., IN BANGALORE

Among the several insect pests of coconut palm, *Nephantis serinopa* Meyr. (Cryptophasidæ, Lepidoptera), is reckoned to be very serious. The caterpillars feed voraciously on the green portion of the leaflets, remaining in silken galleries constructed by them (Fig. 1). Badly infested leaves gradually curl up along their length and eventually dry up. When a large number of fronds are attacked the yield is substantially reduced.

According to previous reports<sup>1-7</sup> the pest has confined itself to coastal or back-water areas except for some records of infestation at Salem, North and South Arcot, etc. "It is fortunate that the pest is confined to more or less defined areas and epidemic outbreaks are not of frequent recurrence, otherwise it is doubtful whether coconut growing in those areas would be profitable at all."<sup>2</sup> The present record of its discovery in Bangalore is of interest to scientists and plant protectionists.

In the month of September 1963 on a report of insect damage on coconut palms in Rajajinagar, a suburb of Bangalore, the plants were examined and found that the type of damage and caterpillars were similar to those of *N. serinopa* (Figs. 1 and 2). The caterpillars were reared

into adults (Fig. 2).<sup>2</sup> The moths (Fig. 3), when compared to specimens received from Mangalore, agreed in all aspects. Later the identity was correctly established after careful examination. This is the first time the insect has been observed in the State in an area other than coastal area where it has been observed ever since 1922.<sup>7</sup> An immediate survey of the area revealed the presence of the pest on other coconut palms in the vicinity, ornamental palms being free.

A bethylid *Perisierola nephantidis*, *Apanteles* sp., and a chalcid pupal parasite were also obtained on this pest from the area.

The life-cycle of the insect was also studied in the laboratory at Bangalore and was found to occupy 69 days from egg to adult during October to December under an average maximum and minimum temperatures of 25.9°C. and 17.4°C. respectively and an average relative humidity of 87%. It is necessary to study the causes which have influenced its spread and multiplication at Bangalore.

Agric. College and M. PUTTARUDRIAH.

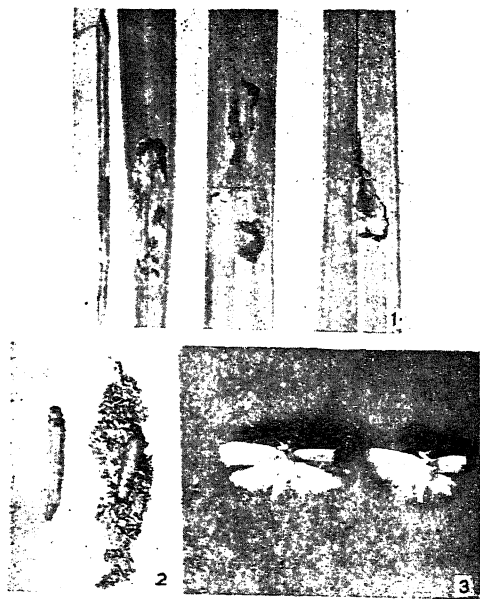
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## A NOTE ON HELMINTHIC NODULES IN LOCAL PIGLETS

TWELVE piglets, below 3 months of age, were slaughtered to ascertain the helminthic fauna and assess the nature and extent of associated lesions. In an earlier report Ahluwalia<sup>1</sup> (1960) reported the occurrence of *Cysticercus* sp. (*Tæniarhynchid*?) in piglets of this age group.

The intestines, in the present study, yielded a number of juveniles and adults of *Ascaris lumbricoides* Linnaeus, 1758 and numerous mature specimens of *Trichuris trichiura* (Linnaeus, 1771) Stiles, 1901. In addition, the intestinal lining, both in the small and large intestines, exhibited nodules of 2-5 mm. in diameter, some of which did not harbour any helminthic stage but in others histological study



FIGS. 1-3. Fig. 1. Leaflets opened out to show the silken galleries with frass of the caterpillars. Fig. 2. Larva, Pupa on the silken gallery and web of the caterpillar. Fig. 3. Adult moths.

showed developing nematodes, one in each, cut with prominent pathological changes around them. The lumen was found free from any other infection. Liver and lung likewise did not yield any parasite, except for the presence of characteristic lesions of *A. lumbricoides* in the liver. The identity of the form, occurring inside the nodules, proved difficult as, in the stained sections, the stages did not show structures other than those of its digestive system and the anterior end also was without such structures as could give any clue to its identification. There appears to be no report of the occurrence of helminthic nodules in the small intestines of pigs. These nodules, encountered in the present study, are briefly described in this communication.

Two of the small intestinal nodules in two sizes had the juvenile stage cut in the centre of well-developed nodules, the larger sized one exhibiting a greater degree of inflammatory reaction on account of a longer stay of the parasite which was of a bigger size too (Fig. 1).

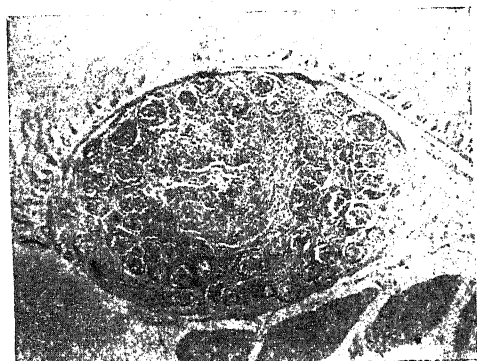


FIG. 1. A section of a small intestine showing a well-developed nodule in the sub-mucosa, revealing numerous secondary germinal centres,  $\times 25$ .

The nodules, lymphocytic in nature, were in the sub-mucous coat, the parasite apparently had entered a lymphoid follicle and consequently hyperplastic activity of the cells of the lymphocytic series had resulted in characteristic formation of a number of secondary germinal centres. As a whole the nodule was surrounded by a well-developed fibrous capsule made up of collagen-fibres and fibroblasts and the blood vessels were congested.

The histological changes of the nodules of large intestine were essentially similar to those in the small intestine (Fig. 2). In some sections of the series, a necrotic mass was present in

the centre of the nodule. The nodules, with an opening in the centre, had identical pathological changes, except for the absence of the parasitic stage.

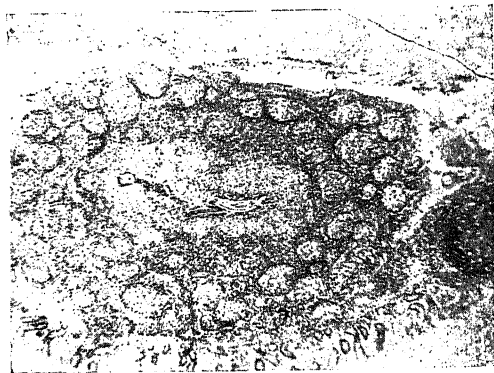


FIG. 2. A section of a large intestine showing a well-developed nodule with nematode larva out of different planes,  $\times 20$ .

The juvenile forms causing nodulation of the gut in pigs belong to species of the genus *Oesophagostomum* Molin, 1861 in which *O. longicaudatum* Goodey, 1925 is reported to produce in its colon nodules of about 5 mm. diameter with an elevation of 2 mm. In case of other species, *O. dentatum* (Rud., 1803) Molin, 1861, the nodules are stated to be very small in size (Morgan and Hawkins, 1949).<sup>2</sup> Goodey (1926)<sup>3</sup> on the other hand stated that there was a complete absence of nodule formation, even in heavy infestations with this species. The nodules, studied by Ahluwalia,<sup>1</sup> have been described as of two distinct types, one of the size of pinhead and the other smaller. The former did not have a larval stage which, however, occurred in case of the latter. In the present case, the nodules, both in small and large intestines, were nearly equal in size to those described for *O. longicaudatum*, normally found in the colon. From their size and location the nodules appear to be those of *O. longicaudatum*. However, a categorical statement is difficult because no adult forms were recovered. The occurrence of nodules in the small intestine is explainable as in ruminants oesophagostomal nodules are frequently seen in intestinal regions other than caecum and colon.

Thanks are due to Dr. B. P. Pande for his guidance; the Indian Council of Agricultural Research for the award of Junior Research Fellowship and the Principal of the College for the facilities provided.

Dept. of Parasitology,  
U.P. College of Veterinary  
Science and Animal Husbandry,  
Mathura, February 12, 1964.

J. P. DUBEY.\*

\* Present address: Division of Microbiology, Central  
Drug Research Institute, Lucknow.

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### BACTERIAL LEAF-SPOT ON *TRIUMFETTA PILOSA* ROTH.

BACTERIAL leaf-spot on *Triumfetta pilosa* growing in the farm area of B.A. College of Agriculture, Anand, was noticed during October 1961. The suscept is a commonly growing weed at several places in India, Abyssinia, tropical Africa and Ceylon.

The pathogen produces numerous spots varying in (i) number from a few to several (150) on both sides of the leaves and (ii) size from pin-point to 2-3 mm. in diameter. Old infected spots drop out leaving holes. The spots are light brown with raised centres, well-defined margin and water-soaked area of 0.5 mm. Sometimes, veins are also attacked. Infection is extensive near the leaf border (Fig. 1) possibly due to tenderness of the part and the presence of hydathodes. Large linear cracking due to infection is often noticeable.

Since *Triumfetta pilosa* (Tiliaceae) is the only suscept of the organism under study and since no members of Cornaceae (1 *Alangium* sp.), Vitaceae (2 *Vitis* spp.), Violaceae (1 *Ionidium* sp.), Leguminosae (2 *Bauhinia* spp., 2 *Cassia* spp., 1 *Tamarindus* sp., 1 *Pisum* sp., 1 *Dolichos* sp. and 1 *Vigna* sp.) and Tiliaceae (4 *Corchorus* spp.) showed infection on inoculation with pure culture, it is proposed to assign it a new name *Xanthomonas Thirumalachari* nov. sp. after Dr. M. J. Thirumalachar. The technical description of the incitant is as under:

#### *Xanthomonas Thirumalachari* Nov. Sp.

Short rods with rounded ends,  $1-2 \times 0.5-0.7 \mu$ , mostly single, rarely in chains of two, gram negative, no endospore, non-acid-fast, motile with a polar flagellum, capsulated; colonies on potato dextrose agar are smooth, circular with entire margin, butyrous, convex, copious and yellow; gelatin liquefied, starch hydrolysed,

casein digested, milk peptonised and litmus reduced; nitrite not produced from nitrate, but ammonia and hydrogen sulphide produced from peptone; VP. and M.R. tests negative; citrate utilised but not uric acid; tolerates 3% sodium chloride; acid but no gas from glucose, sucrose, maltose and lactose; no growth in salicin; tributyrin and several other fats hydrolysed; facultative anaerobe; optimum temperature for growth 27-31°C; thermal death-point 53°C.



FIG. 1

Pathogenic to *Triumfetta pilosa* only, producing spots on leaves; found at several places in Gujarat State.

We gratefully acknowledge the valuable help of Dr. M. V. Desai, Professor of Bacteriology, B.A. College of Agriculture, Anand.

S. B. Garda College and A. C. PADHYA.\*  
B.P. Baria Science Institute, M. K. PATEL.  
Navsari (Gujarat State),  
August 10, 1963.

\* Present address: Sarabhai Chemicals Research Institute, Ahmedabad, Gujarat State.

### THE IDENTITY OF *CYATHULA* *CAPITATA* MOQ.\*

ON the basis of the study of material collected from different altitudes of Simla hills Bakshi<sup>1</sup> merged *C. capitata* Moq. with *C. tomentosa* Moq., thus reducing the number of Indian species of *Cyathula* to three. He remarked that differentiation of *C. tomentosa* and *C. capitata* on the basis of densely tomentose or woolly nature and sparsely hairy or nearly glabrous nature respectively, as has been done by taxonomists, is untenable. He emphasized that the development of hair is related to altitude, the specimens being densely hairy at lower altitudes and becoming sparsely so or nearly glabrous at higher ones. He thus concluded that *C. tomentosa* and *C. capitata* are "ecotypes of each other".

Within the last few years, we had occasion to visit more than once the different localities in Simla hills, as also Garhwal Himalayas and Siwalik ranges of Mussoorie and Chakrata, and to collect from different altitudes a large number of specimens of both *C. tomentosa* and *C. capitata*. Besides, the two species were also studied under natural conditions. Though *C. tomentosa* is distributed at comparatively lower altitudes (2-6500 ft.) than *C. capitata* (6-9000 ft.)<sup>3</sup> it has been observed that the hairy nature of the plants bears no relation to the altitude. At a number of places the specimens of both the species were found growing at the same altitude, those of *C. tomentosa* with the characteristic woolly tomentum and of *C. capitata* with sparse hairs.

In addition to the hairy character, the two species also stand apart from one another in certain other characters. While the leaves of *C. tomentosa* are thick with very indistinct veins, those of *C. capitata* are thin with clearly visible veins on the lower surface. Further, in the former species the spikes are long and peduncled bearing closely or distantly arranged globose heads of flower clusters, while in the latter the globose heads are either solitary or subsolitary and peduncled.

These differences seem to be sufficient to justify the retention of *C. capitata* as an independent species as has been treated by earlier taxonomists.<sup>2-4</sup>

The authors are grateful to Professor V. Puri for his valuable suggestions and interest.

School of Plant Morphology, Y. S. MURTY.  
Meerut College, V. SINGH.  
Meerut, February 4, 1964.

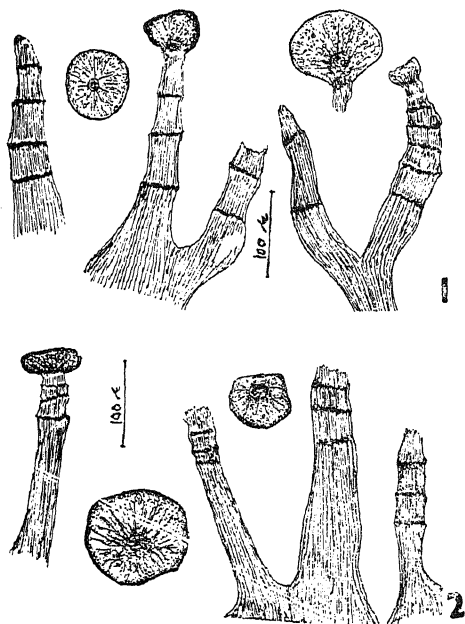
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### *TRETAPILEUS SPHAEROPHORUS* (BERK. AND CURT.) HUGHES AND DEIGHTON FROM INDIA

IN 1960, Deighton<sup>2</sup> described an interesting fungus occurring saprophytically on dead twigs of *Cajanus cajan* L., *Hibiscus esculentus* L. and *Thevetia neriifolia* Juss. ex Steud. from Sierra Leone. A comparison of this fungus made by Deighton with the type material of *Monotospora sphaerophora* of Berk. and Curtis<sup>1</sup> led to the conclusion that the two were conspecific. Deighton<sup>2</sup> also examined type material of *Tretopileus opuntiae* Dodge<sup>3</sup> and found that it was identical with *Monotospora sphaerophora* Berk. and Curt. He, therefore, proposed the name *Tretopileus sphaerophorus* (Berk. and Curt.) Hughes and Deighton for that fungus. The genus *Tretopileus* is thus monotypic.

An identical fungus was collected by the author during January, 1964, at Ganeshkhind (Poona University Campus), Poona, growing on dried stems of *Ipomea biloba* Forsk. and *Butea monosperma* O. Ktze. The fungus forms dark synemna-like structures with gemmæ at the tips. The gemmiferous stipes are dark, mostly erect or slightly curved, simple or forked. The stipes are 100-400  $\mu$  long and 80-128  $\mu$  broad at the base, tapering towards the apex, where they are 16-40  $\mu$ , composed of numerous parallel septate hyphæ 2-3  $\mu$  thick, adherent to each other. The gemmæ are terminal and solitary, shortly obconoid, slightly concave at the base, 62-112  $\mu$  across, composed of numerous subhyaline ascending septate hyphæ firmly adherent to each other and covered by a dark brown cuticle except over the area of small pore-like structures interpreted as germ pores by Dodge.<sup>3</sup> The gemmæ are easily detached. The stipes continue their growth after the gemma is shed forming dark annular articulations. Proliferation continues, giving a distinctly jointed appearance to them. Nine such rings or annuli could be counted in the present material (Figs. 1 and 2).



FIGS. 1-2. Fig. 1. *T. sphærophorus* on *Ipomea biloba* Forsk. Fig. 2. The same on *Butea monosperma* O. Ktze.

A comparison of measurements of stipes and gemmæ in the Indian material with those of *Tretopileus sphærophorus* from Cuba and Sierra Leone showed that except for the greater width at the base of the stipes there was no marked difference between them (see Table I).

TABLE I

Specimens	Country	Length of stipe	Breadth of stipe		Diameter of gemmæ
			At the base	At the apex	
<i>Tretopileus sphærophorus</i>	Cuba	70-400 µ	40-80 µ	25-45 µ	53-137 µ
do.	Sierra Leone (Africa)	80-750 µ	40-70 µ	20-50 µ	60-130 µ
do.	India	240-400 µ	80-125 µ	16-40 µ	64-112 µ

The Indian fungus therefore has been assigned to *Tretopileus sphærophorus*. This constitutes a new record for India, and *Ipomea biloba* Forsk. and *Butea monosperma* O. Ktze. new hosts for the species.

Berkeley and Curtis (1868) described *Monotropa sphærophora* as possessing a conical fertile stipe of elongated compact cells bearing a terminal conidium. Deighton<sup>2</sup> however showed that the structure described by Berkeley and Curtis as a conidium was in fact a multicellular

gemma and therefore the genus *Tretopileus* must be placed in *Mycelia sterilia*.

The author has great pleasure in thanking Dr. T. S. Mahabale for the encouragement and help given. He also wishes to thank Dr. M. S. Balakrishnan for useful suggestions.

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University of Poona,  
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S. D. PATIL.

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### CYTOLOGICAL APPROACH TO THE LIFE-HISTORY OF *SALVINIA AURICULATA* AUBLET.

RECENT investigations carried out in this laboratory on *Marsilea minuta* complex<sup>5</sup> emphasized the importance of cytological approach in understanding the mode of aberrant spore formation amongst the heterosporous ferns. A perusal of the literature reveals the occurrence of the above phenomenon in the life-history of *S. auriculata*.<sup>1-4</sup> Although the earlier investigators have given somewhat imperfect account of the abnormal spore formation in this species, nothing is known about the real cause. It was, therefore, thought desirable to investigate the species more critically, particularly from a cytological angle.

*S. auriculata* occurs in a wild state in the American tropics<sup>6</sup> and according to recent taxonomic study based upon Argentinean material, is probably conspecific with *S. herzogii*.<sup>2</sup> The species is under successful cultivation in several botanical gardens of India. The present study is based upon the material collected from the Government College, Hoshiarpur (Punjab).

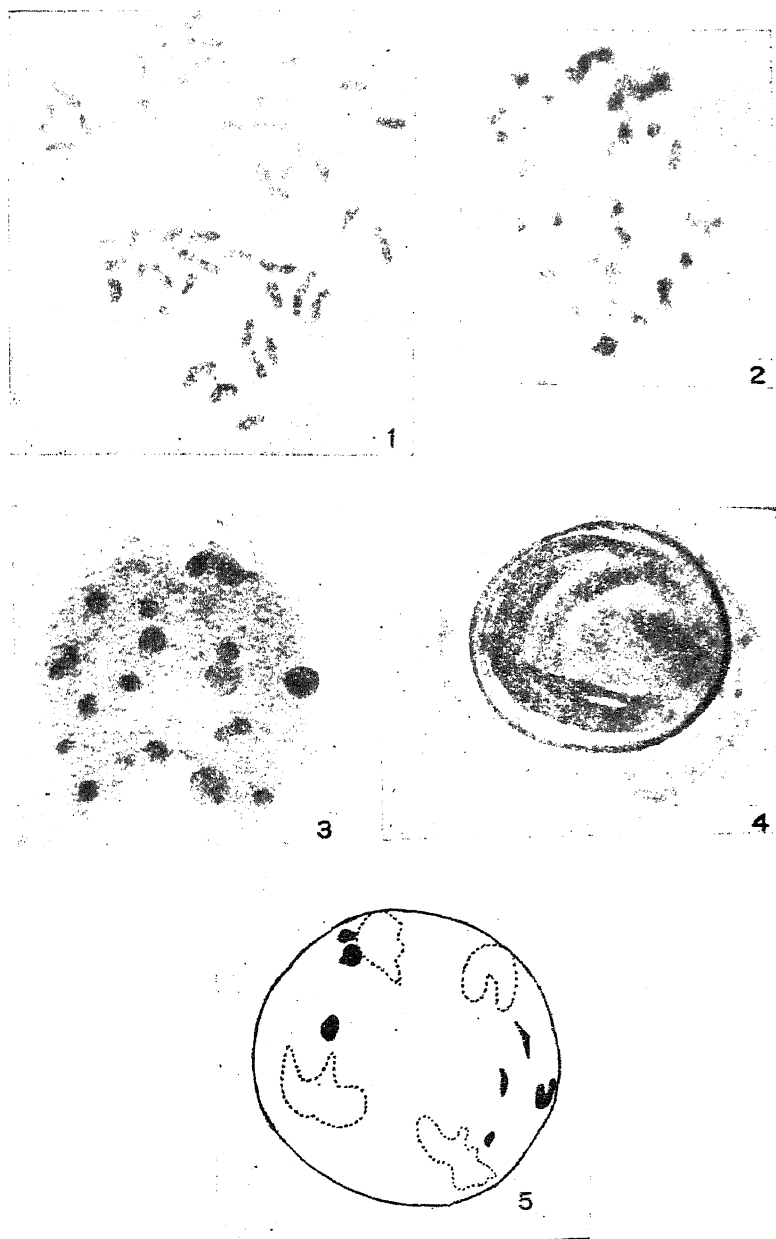
Forty-five chromosomes have been invariably counted at metaphase in the cells of young leaves (Fig. 1). Most of the chromosomes have a nearly median or sub-median centromere and only a few appear to have subterminal one. The chromosomes differ markedly in size. In view of the presence of 9 as the gametic number in *S. natans*,<sup>3</sup> the Hoshiarpur population of *S. auriculata* is pentaploid.

Preliminary meiotic studies made from the spore mother cells of mega- and microsporangia reveal the presence of bivalents and univalents at Metaphase I followed by highly irregular anaphasic separation (Fig. 2). Due to the paucity of exceptionally clear cells, it was not possible to confirm the presence or absence of multivalent associations. Tetrad nuclei are

markedly unequal with laggards (Fig. 3), and so are the resulting microspores (Fig. 4), which are not expected to be viable. The single megaspore formed in a megasporangium lacks contents and appears shrivelled (Fig. 5). It appears extremely difficult at this stage to suggest the

mode of origin of the present race because to the writers' knowledge todate no sexual form of this species with normal meiosis is known.

The results of the present study direct our attention to an earlier report of the occurrence of apogamy in this species by Mahabalé and



FIGS. 1-5. Fig. 1. Somatic metaphase showing 45 chromosomes,  $\times 1,700$ . Fig. 2. Anaphase I showing irregular behaviour of chromosomes,  $\times 1,900$ . Fig. 3. Spore mother cell with unequal-sized tetrad nuclei and laggards at Telophase-II,  $\times 2,000$ . Fig. 4. Microsporangium containing unequal-sized, non-viable microspores,  $\times 200$ . Fig. 5. Megasporangium with a single, shrivelled megaspore,  $\times 140$ .

D'Mello.<sup>4</sup> A critical analysis of 100 sporangia indicates complete absence of this phenomenon (comparable to apogamous homosporous ferns) in the present taxon. A cumulative evidence from chromosome associations at diakinesis, overall meiotic aberrations, and sporangial contents, is strongly suggestive of its being a sterile race. The only possible method by which the present taxon seems to have been preserved is the efficient vegetative reproduction in aquatic habitat.

The details of the investigation involving sporangial development, sporogenesis, meiosis, spore formation and karyotype are being worked out and will be published in due course.

We are deeply indebted to Prof. P. N. Mehra for his kind suggestions and keen interest in this work. Thanks are due to Mr. B. S. Gill for photomicrographs.

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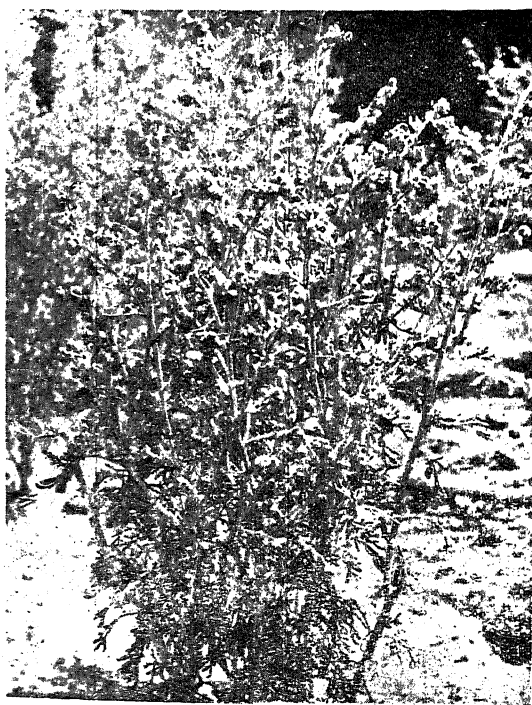
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### OCCURRENCE OF TWO MORPHOLOGICAL TYPES IN *A. PALLENS* WALL

THE genus *Artemisia* includes more than 280 species distributed in South America and South Africa. About 34 species have been recorded in India occurring in the temperate regions of the north-western Himalayas. The genus includes several species of medicinal value, the best known being *A. cina*, which is the source of santonine. Others are sources of highly-prized volatile oils.

One of the species cultivated in South India, particularly in the Mysore State, is *A. pallens* Wall, an aromatic herb cultivated for its leaves and flowers. The fragrant leaves are used for floral decoration and in religious offerings. On distillation the plant yields a highly aromatic oil which is imported by the perfumery trade in America.

Sundar Rau, distiller in Mysore, has, on the basis of experience, envisaged the existence of



FIGS. 1-2. Fig. 1. *Artemisia pallens*—Type I. Fig. 2. *Artemisia pallens*—Type II.



two different varieties in *A. pallens*. According to him the oil of one is superior compared to the oil of the other (personal communication) but no experimental evidence has been offered in support of this claim.

*A. pallens* (popularly known as *Davana*) has been under cultivation in the experimental farm of CIMPO. In a random population of *A. pallens*, two distinct morphological types have been isolated. In one, the basal leaves are almost entire while the leaves in the upper half are somewhat dissected. Further, this type is short in stature and flowers early. In the other type, the plants are tall and the leaves highly dissected throughout the plant. Flowering starts much later in this type.

The breeding behaviour of the two types and the difference, if any, in the chemical composition of the oil are under study.

CIMPO, Bangalore,  
April 29, 1964.

K. V. SRINATH.  
M. N. RAMASWAMY.

#### OCCURRENCE OF *SEPEDONIUM* *CHRYSOSPERMUM* (BULLIARD) FRIES IN DELHI SOILS

THE genus *Sepedonium* is based on the presence of globose tuberculate spores which are not conidia but chlamydospores. No species of this genus has been described from India. While studying the keratinophilic flora of Delhi soils by Vanbreuseghm's hair-baiting technique, the author observed that a species of *Sepedonium* appeared frequently on the soil plates. The fungus was isolated in pure culture on Saboraud-dextrose agar and identified as *Sepedonium chrysospermum* (Bulliard) Fries. Four isolates of this fungus were obtained, two from grassland soils and two from soil samples taken from near chicken pens. The fungus has been reported from England and America (Dale, 1912; Leclercg and Smith, 1928), but it is being reported for the first time from India.

*Description of the fungus.*—Colonies are at first white, floccose then becoming golden yellow. Aerial hyphae hyaline, septate, branched, bearing short, simple or clustered branches on tips of which chlamydospores are borne. Chlamydospores numerous, arcogenous occurring singly or in short chains, globose, warted, light yellow or golden yellow, thick-walled,  $10.4\text{--}26\ \mu$  (Average  $17\ \mu$ ) in diam. (Fig. 1).

The species of *Sepedonium* are saprophytes but are of academic importance to Medical mycologist because of their close morphological

similarity to *Histoplasma capsulatum* (Darling) Rocha lima, which besides being a saprophyte, is a highly pathogenic mould causing a serious respiratory disease in man. *Sepedonium* has been confused with *Histoplasma capsulatum* by a few workers. The latter, however, can be distinguished from the former by characteristic stout tuberculations (not thin spine-like as in *Sepedonium*), presence of yeast-phase and

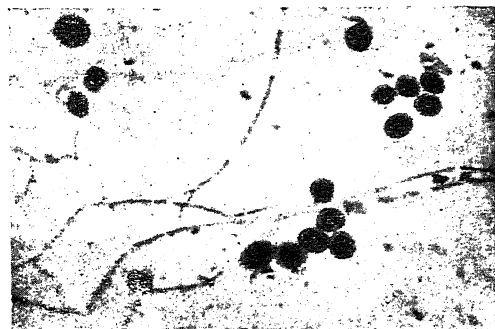


FIG. 1. *Sepedonium chrysospermum* showing chlamydospores,  $\times 400$ .

animal pathogenicity. It was considered desirable to test the animal pathogenicity of the species for which white mice were inoculated intraperitoneally and intravenously with a concentrated suspension of fungus spores along with mucin. Six weeks after inoculation, the mice were sacrificed. On dissection no lesions were found on any of the organs and the fungus also could not be recovered in culture by inoculation of pieces of liver, spleen and lungs on Saboraud-dextrose agar. The culture when inoculated on brain-heart infusion agar did not convert to a yeast-phase as is the case with *Histoplasma capsulatum*.

The author is indebted to Lt.-Col. Dri Si L. Kalra for providing the facilities for this work.

Dept. of Microbiology,  
All-India Institute of

H. C. GUGNANI.

Medical Sciences,  
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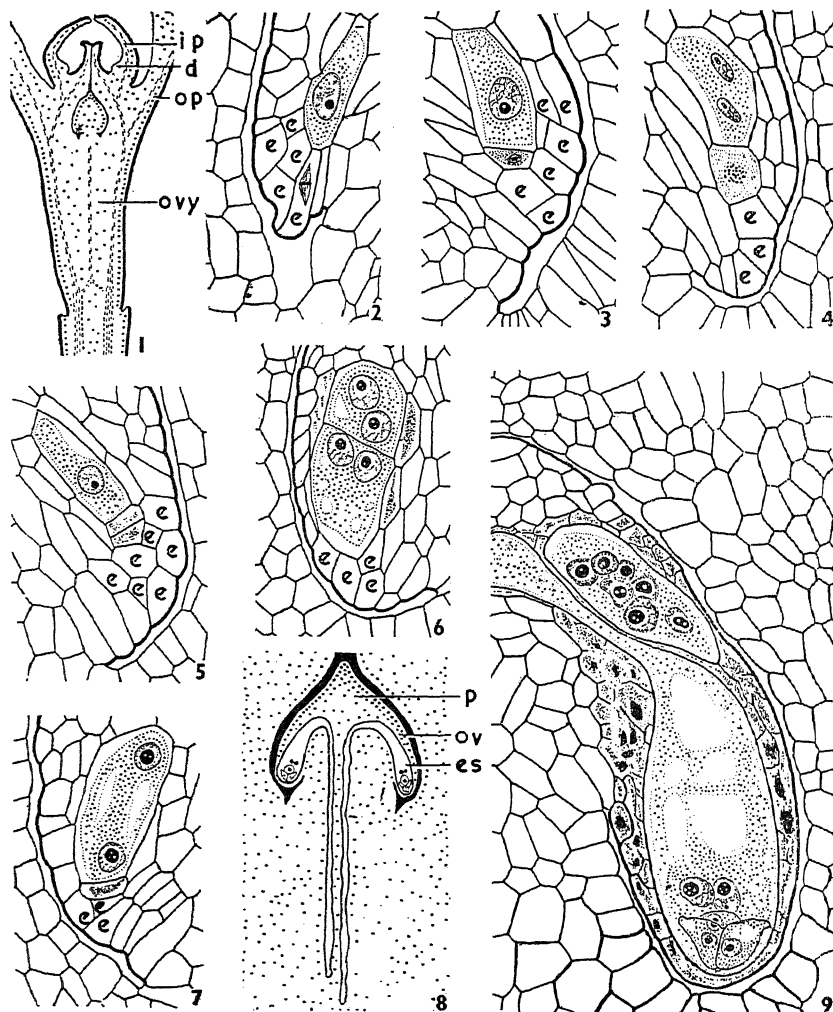
**FEMALE GAMETOPHYTE OF  
*BUCKLEYA LANCEOLATA* SIEB.**

ET ZUCC.

THE family Santalaceæ is characterized by the *Polygonum* type of female gametophyte (see Johri and Bhatnagar<sup>1</sup>). While working on *Buckleya lanceolata*, a root parasite endemic to Japan, the development turned out to be bisporic.

The flowers are strictly dicæcious and tetramerous. The solitary female flower is either

terminal or axillary with a unilocular, inferior ovary (Fig. 1) bearing eight prominent ribs. Unlike other members of the Santalaceæ, there are two alternating whorls of persistent perianth lobes in *Buckleya* (Fig. 1). The placenta is short and thick with three or four subapically attached and pendulous ovules which lack the usual distinction into the nucellus and integument.



FIGS. 1-9. Fig. 1. Longisection of female flower at megaspore mother cell stage,  $\times 55$ . Fig. 2. Megaspore mother cell,  $\times 950$ . Fig. 3. Dyad,  $\times 950$ . Fig. 4. Nucleus of micropylar dyad cell in division, the chalazal dyad cell shows two nuclei,  $\times 950$ . Fig. 5. Triad with two degenerated megaspores and functional (chalazal) dyad cell,  $\times 950$ . Fig. 6. Each of the dyad cell shows two nuclei,  $\times 950$ . Fig. 7. 2-nucleate embryo-sac with remnants of the degenerated micropylar dyad cell,  $\times 950$ . Fig. 8. I.s. portion of ovary showing the chalazal extension of embryo-sac,  $\times 180$ . Fig. 9. Same, upper part of embryo-sac with the egg apparatus and polar nuclei; "antigone" contains seven free nuclei,  $\times 950$ . (d, disc; e, epidermis and its derivatives; es, embryo-sac; ip, inner whorl of perianth; op, outer whorl of perianth; ov, ovule; ovy, ovary; p, placenta.)

Each ovule shows 1-3 hypodermal archesporial cells which function directly as megaspore mother cells (Fig. 2). Generally, only one mother cell develops further and after meiosis I results in a dyad with the micropylar cell smaller and ephemeral (Fig. 3). Even if the micropylar dyad cell enters meiosis II, the division may or may not be followed by a wall so that either two megaspores are formed (Figs. 4, 5) or the micropylar dyad cell becomes binucleate (Fig. 6). The development of the female gametophyte, therefore, conforms to the *Allium* type. Rarely, the embryo-sac may be formed from the micropylar dyad cell (Fig. 9) conforming to the *Endymion* type (Battaglia<sup>2</sup>). The nucleus of the non-functional (micropylar or chalazal) dyad cell does not degenerate promptly, but may sometimes divide forming the so-called "antigone" (Maheshwari<sup>3</sup>).

The nucleus of the chalazal dyad cell undergoes three successive divisions giving rise to 2- (Fig. 7), 4- and 8-nucleate gametophytes. The starch grains appear in the embryo-sac even at the 4-nucleate stage and their concentration increases during the development of endosperm and embryo. The antipodal cells degenerate precociously so that the mature embryo-sac shows only the egg apparatus and two polar nuclei (Figs. 8, 9). At this stage the chalazal end of the embryo-sac extends into the placenta and elongates downward almost up to the vascular strand so that the outline of the gametophyte becomes (∩ or ∟)- shaped left or right (Fig. 8).

To the best of our knowledge this is the first report of a bisporic development of the embryo-sac in the Santalaceae. It is likely that some other plants may also show a similar behaviour and there is urgent need for further investigation.

I am indebted to Professor B. M. Johri for guidance; to Professor P. Maheshwari for stimulating discussions; to Professor Y. Ogura, Dr. T. Yamazaki (Tokyo, Japan) and Dr. Y. Yamada (Gunma, Japan) for providing the material on which this study is based; and to the Council of Scientific and Industrial Research, Government of India, for financial assistance.

Department of Botany,  
University of Delhi,  
Delhi-6, India, March 7, 1964.

B. RAJ.

# **OCCURRENCE OF TWO ENTOMOPHAGOUS FUNGI ON SUGARCANE PESTS IN TANJORE AREA OF MADRAS STATE**

PARASITISATION of mealy bugs by fungi was reported by Speare from Honolulu in 1912. In India also, parasitic fungi have been reported occurring on some of the major sugarcane pests. Parthasarathy (1950) was probably the first to record parasitisation of the leafhopper, *Pyrilla perpusilla* Wlk. by *Metarrhizium anisopliae* Metch. in Madras State. Rao (1959) reported parasitisation of the pink mealy bug, *Saccharicoccus sacchari* Ckll., and of a species of grasshoppers by *Aspergillus parasiticus* Speare at Coimbatore.

Recently, during the course of observations by the author on sugarcane pests in Tanjore area of Madras State, two species of fungi, *Aspergillus parasiticus* and *A. flavus* were recorded on the sugarcane mealy bug, *S. sacchari* and on the internode borer, *Proceras indicus* Kapur, respectively. The latter parasitisation is of special significance, because record of fungal parasites on moth borers of sugarcane appears to be rather rare. The internode borer, *P. indicus*, is migratory in habit and its larvae are quite often met with outside the cane stalk in between the leaf-sheath and the cane, where they are vulnerable to fungal parasitisation. Under Tanjore conditions, the fungi generally become active from June-July after a few showers of rain have been received. Their activity is at its maximum during the monsoon months of October, November and December, after which there is a rise in temperature resulting in adverse condition for development of the fungi.

The two species recorded in Tanjore area could easily be cultured in the laboratory on the oats-agar medium. Laboratory inoculation of *A. parasiticus* on mealy bugs proved quite successful, while that of the internode borer by *A. flavus* was only partially successful.

The pathogens were identified by the Department of Insect Pathology, University of California, Berkeley, to whom the author is grateful. Thanks are also due to Shri A. N. Kalra, Indian Institute of Sugarcane Research, Lucknow, for his valuable suggestions in the preparation of this note.

Indian Institute of  
Sugarcane Research Outpost,  
Koothanallur (Tanjore), February 24, 1964.

H. DAVID.

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## REVIEWS

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**Mathematical Crystallography and the Theory of Groups of Movements.** By Harold Hilton. (Dover Publications Inc., New York), Pp. 262. Price \$ 2.00.

This is a republication of the original (1903) edition. Crystals are segregated into classes in accordance with the movements which transform crystals into themselves. The various classes of crystals are then studied by the structure of the particular group which represents the movements of that class. The author provides a careful treatment of such matters as the stereographic projection, properties common to symmetrical and asymmetrical crystals, the theory of groups, the co-ordinates of equivalent points, the crystallographic axes and axial ratios, the dependence of physical properties of crystals on symmetry, the structure-theory, lattices and translations, symmetrical lattices, the Bravais structure-theory, properties of geometrical operations, infinite groups of movements, triclinic and monoclinic groups, orthorhombic groups, tetragonal, rhombohedral, hexagonal and regular groups, space partitioning, crystal molecules, and other pertinent topics.

C. V. R.

**Thermodynamics of Clouds.** By Louis Dufour and Raymond Defay. (Academic Press, Inc., New York), 1963. Pp. 255. Price \$ 10.00.

The physical nature of clouds, how they form and the circumstances which lead to the precipitation of rain or snow from them are subjects which are of the highest interest and form important aspects of the science of meteorology. They have been intensively studied of recent years from several different points of view. An extensive literature has grown up dealing with this field. Especially since the advent of rain-making experiments attention has been pointedly drawn to the theoretical aspects of the behaviour of rain-clouds and the practicability of controlling the same. It may be recalled that N. H. Fletcher's book on the *Physics of Rainclouds*, published by the Cambridge University Press, was reviewed in *Current Science* for the month of May 1963. The complexity of the subject is sufficiently indicated by mentioning some of the factors involved in it. Apart from the possibility of the particles in the clouds being either droplets of water or crystals of ice, we

are also concerned with the conditions in the atmosphere, its water-vapour content and its temperature, as also the presence of extraneous material dissolved or included in the cloud particles. The size of the droplets and the shape of the ice-crystals are also relevant to the problem.

As the title of the book indicates, its authors have adopted a thermodynamic approach to the problems of drops and crystals in the atmosphere. They develop the theory with detailed accounts of procedures, basic physical concepts and hypotheses. The properties of surfaces and interfaces are discussed from the initial statements up to the final formulæ. The book contains numerical applications of the formulæ obtained as well as numerous tables showing the results of the calculations.

The book represents a serious attempt to handle a subject of high importance on the basis of acceptable theory. Unquestionably, therefore, it merits the attention of meteorologists and others interested in the field.

C. V. R.

**Physical Geochemistry.** By F. Gordon Smith. (Published by Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, U.S.A.; 10-15 Chitty St., London W-1), 1962. Pp. 624. Price \$ 15.00.

Geochemistry may be defined in a general way as the study of geological processes which are essentially chemical in nature. In particular it is concerned with the chemistry of rock and mineral formation and ore deposition. The chemical processes involved are essentially heterogeneous equilibria under varying conditions of pressure and temperature, and include all combination of phases solid, liquid and gas. As such any text-book on geochemistry cannot exclude physical aspects of the problems, namely, the physics of solids, especially minerals, and the physics of crystals and crystal formation.

Early geochemical work was chiefly confined to ores and their analyses and the extraction of minerals. Ever since the establishment of the Geophysical Laboratory by the Carnegie Institution of Washington, early in the present century, systematic research work on geochemical problems has been in continuous progress, and with the coming up within the last two decades

of other institutes in Russia and countries of Europe, devoted to the study of earth sciences there is accelerating progress in this field of research. We have at present an accumulation of exact and useful data on high-pressure high-temperature reactions of minerals and their phase equilibria and phase-transitions, and geochemistry has become a separate discipline by itself.

The object of the author of the publication is to provide a text-book on physical geochemistry which may be useful to graduate students of geology in their classes and seminars. Accordingly he has limited the coverage to those earth processes which involve melting and crystallization of rocks, and formation of primary hypogene mineral deposits.

The book is divided into two parts. Part I which is devoted to the theoretical aspects and terminology of phases, systems, and processes contains chapters on structure of matter, crystals, crystal defects and crystal polymorphs, heterogeneous equilibria, phase rule and phase diagrams. Part II deals with physico-chemical systems and petrogenesis and include chapters on silicate systems and igneous processes, various types of magmatic and hydrothermal processes, igneous and metamorphic rocks, pegmatitic and contact metasomatic deposits, hydrothermal mineral deposits. The concluding chapter is on geothermometry and geobarometry. There are also a number of problems given at the end to help the students in their reading.

The book presents a lot of information in a collected form which otherwise can be found only scattered in the scientific literature. In this respect the publication will be useful to students of geology as a supplementary text-book.

A. S. G.

#### The Dithiocarbamates and Related Compounds.

By G. D. Thorn and R. A. Ludwig. (Elsevier, Amsterdam), 1962. Pp. 298. Price 40 sh.

The dithiocarbamates and the closely related thiuram monosulphides and disulphides have been studied intensively by chemists and biochemists. The uses of these compounds range from Antbause (a medicine for treatment of chronic alcoholism) to Zineb (a foliage fungicide for potatoes, etc.).

After a brief introductory chapter, the preparation, the physico-chemical properties and the chemical reactions of these compounds are treated lucidly; the sections on isothiocyanate formation, and the effect of pH on these systems are well reviewed. The value of the five tables

giving literature references and other data of these compounds would have been increased if the yields were reported in them.

Then follows the chapter on the analysis of these compounds (a very important aspect in industrial preparations) in which the assembly used by the authors at the London Institute (Ontario), for several years, is given in detail. The applications of dithiocarbamates in inorganic analysis, and the preparation and properties of various metal complexes are reviewed.

The second part of the book (4 chapters, 100 pages) deals with the biochemical investigations, fungicidal action, and application in medicine and agriculture; it is a neat summary of all the investigations and methods, the prevailing views on the cause and nature of activity, and incorporates a considerable amount of yet unpublished material especially of the authors and the Dutch school. It contains six useful tables and 400 references. This part of the book will be of special interest to agricultural chemists, pharmacists, and biochemists.

The authors have taken great trouble to sieve the literature from all parts of the world, and found in several journals and patents. The titles of these papers are given in the bibliography of more than 1,000 references.

G. B.

Soil Conservation in India. By M. S. V. Rama Rao. (Indian Council of Agricultural Research, New Delhi), 1962. Pp. x + 280. Price Rs. 10-00.

The control and prevention of soil erosion is one of the recognised methods of increasing soil fertility and retention of moisture. This work has rightly been given a high priority in the Third Five-Year Plan. The target to be achieved under this programme has been set at 15 million acres during this Plan period. This requires the assistance of a big team of agricultural extension workers with good technical knowledge in this field. As this number is at present very limited, the Indian Council of Agricultural Research requested the author Sri M. S. V. Rama Rao to bring out an authoritative publication on the subject which will provide practical guidance on soil conservation and also serve as a Text-Book for use in agricultural colleges.

The book deals with the causes of soil erosion, principles and techniques of maintaining productive capacity, and the part played by Sciences like Agronomy, Forestry, Hydrology, and range management in controlling erosion. The book is comprehensive in coverage and its usefulness would have been enhanced if the topics dealt with were treated more thoroughly.

For example, the chapter on Conservation Hydraulics could have dealt with losses of head occurring in the flow of earth, cast iron and other pipes. The chapter on Hydrology could have dealt with factors governing and measurement of infiltration capacity, laws governing movement of moisture in soil, and in the chapter on Storage Reservoirs, the Indian practices extending over more than a thousand years, in constructing outlets in earth bunds and spillways for tanks, could have been included. There are a number of statements which require minor corrections. For example, the statement on page 39 that 61½% is lost by contraction and resistance. It is only 38½% that is lost in resistance to flow. The 61½% is the actual discharge of the theoretical value.

The get-up is very good and the price is reasonable.

N. S. G.

**Symbiotic Associations—Thirteenth Symposium of the Society for General Microbiology, 1963.** Edited by P. S. Nutman and Barbara Mosse. (Cambridge University Press), 1963. Pp. x + 356. Price 50 sh. net.

This 13th Symposium volume of the Society for General Microbiology is a welcome addition to our knowledge of symbiotic associations. As in the previous symposia of the Society the standard attained is high. The information on different aspects of symbiosis, involving micro-organisms, plants and animals is brought together at one place. It is divided into two sections—Plant Associations and Animal Associations—the whole is preceded by a discussion by Dubos and Kessler which considers the general subjects of specificity, the influence of external factors and the creative manifestations of symbiosis.

There are seven papers on plant associations and six on animal associations although Nüesch's article on 'Defence Reactions in Orchid Bulbs' appears at the end, under the latter, due to its late submission as explained by the editors in the preface. Under plant associations the inclusion of Nicholas' paper on 'The Biochemistry of Nitrogen Fixation' is amply justified by his statement on page 118, 'Although little is known about the biochemistry of the symbiotic system in which it involves a complex host symbiont relationship, there is no doubt that its resolution will be made easier when the precise mechanism of fixation is established in the free-living ro-organisms.'

Most of the papers are in the form of authoritative critical reviews, e.g., Nutman's on legume symbiosis, Bons's on nodulation in non-legumes, Nicholas' on biochemistry of nitrogen fixation, etc., in their own specialised field. For the general reader the merit of the book lies not only in the information it contains but also in its emphasis. It has stressed that symbiosis is exceedingly common and sufficiently wide in its coverage—from the marginal case of lysogeny in bacteria to the rumen flora and fauna of mammals. It is by no means exhaustive but is sufficiently diverse to emphasize the biological importance of the subject. The aim of the symposium is to bring together information about the types of interactions that occur between the symbionts and this has been fully realised in the present volume under review.

R. N. SINGH.

#### Books Received

- Non-Stoichiometric Compounds.* Edited by Lyon Mandelcorn. (Academic Press, New York-3), 1963. Pp. xiii + 674. Price \$ 22.00.
- Pulmonary Deposition and Retention of Inhaled Aerosols.* By T. F. Hatch and Paul Gross. (Academic Press, New York-3), 1964. Pp. xiv + 192. Price \$ 5.95 (Cloth-bound); \$ 3.45 (Paper).
- Ministry of Agriculture Fisheries and Food Technical Bulletin No. 2—Laboratory Methods for Work with Plant and Soil Nematodes.* By J. Basil Goodey. (Ministry of Agri. Fisheries and Food, Whitehall Place, London S.W. 1), 1963. Pp. 72. Price 8 sh. 6d.
- Selected Papers of Ernst George Pringsheim.* By C. B. van Niel. (Institute of Microbiology, Rutgers, The State University, New Brunswick, New Jersey), 1963. Pp. 331. Price \$ 6.50.
- The Journal of the Indian Botanical Society (Vol. XLII—A)—Maheshwari Commemoration Volume.* Edited by T. S. Sadasivan. (Indian Botanical Society, Madras-5), 1963. Pp. xxxiv + 330. Price Rs. 32-00.
- Beyond Newton an Explanation of Gravitation.* By D. B. Larson. (North Pacific Publishers, P.O. Box 5044, Portland-13, Oregon, U.S.A.), 1963. Pp. v + 160. Price 5.00.
- Fluidised Particles.* By J. F. Davidson and D. Harrison. (Cambridge University Press, London, N.W. 1), 1963. Pp. xv + 155. Price 35 sh.
- International Conference on Cosmic Rays Proceedings (Vol. 4). Extensive Air Showers.* (The Department of Atomic Energy, Government of India, Tata Institute of Fundamental Res., Bombay-5), 1963. Pp. 322. Price Rs. 20-00.

## SCIENCE NOTES AND NEWS

### A Selenium Cycle in Nature?

The fundamental role that selenium plays in cellular metabolism has been emphasized in many biological researches. Dr. A. Shrift of the Kaiser Foundation Research Institute, Richmond, California, has reviewed recent work on the subject and presents convincing data to support a hypothesis that in nature there exists a selenium cycle, even as there are the well-known biological cycles for carbon, nitrogen and sulphur. The fundamental processes in these cycles are that within each there occur organisms which reduce the most oxidized form of the element, e.g.,  $\text{CO}_2$ ,  $\text{NO}_3$ ,  $\text{SO}_4$ , forming the first half of the cycle, and there are other organisms which complete the cycle by oxidizing the reduced element to its initial state.

As regards the proposed selenium cycle, it is becoming increasingly established that bacteria, fungi and higher plants, particularly species of *Astragalus*, metabolize selenate ( $\text{Se}^{+6}$ ) or selenite ( $\text{Se}^{+4}$ ) to the level of selenide. The biological synthesis of various seleno-amino-acids and of the seleno-ether, dimethylselenide by plants and micro-organisms constitute evidence for the first half of such a cycle.

Evidence for the remainder of the cycle is fragmentary. A biological transformation of selenium valence  $-2$  to at least valence zero has not been described in literature. But there are references that some micro-organisms are able to oxidize selenium (zero) to selenium ( $+3$ ). The mounting evidence that selenium is an essential micronutrient also suggests the existence of a cycle in nature.—(*Nature*, 1964, 201, 1334.)

### Bibliography on Coffee

The Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, has brought out a *Supplement No. 1* (181 pages) to the Bibliographical List No. 1 on Coffee issued in 1960. The *Supplement* contains all the literature received on coffee at the Orton Memorial Library from November 1959 to October 1963. It has been compiled by G. P. de Montoya and contains a total of 1546 bibliographical references that have been classified under a number of convenient subheads. There is also an author index.

As a feature of the bibliographical series of the Orton Memorial Library, all the literature

included in the *Supplement* can be obtained through the Photocopy Service.

### Thermal Synthesis of Natural Amino-Acids

Scientists concerned with chemical evolution and the origin of life have in recent years synthesized simple biochemical organic compounds (such as amino-acids which occur in proteins) from substances thought to have been present in the primordial atmosphere of the earth. The sources of energy that have been used in these reactions include electric discharge, ultra-violet light,  $\alpha$ -,  $\beta$ -,  $\gamma$ - and X-rays. Thermal energy has, however, not been used, it being believed as insufficient for primordial synthesis.

Now Sidney W. Fox and Kaoru Harada of Florida State University have succeeded in synthesizing amino-acids in a "postulated primitive terrestrial atmosphere", with heat alone. Whereas electric discharge have produced 8 different amino-acids, the method of Fox and Harada, as described in *Nature* (1964, 201, 335) has yielded all the amino-acids (except cystine and methionine) common to protein.

In order to synthesize amino-acids thermally methane was bubbled through an aqueous solution of ammonia, and the mixed gas was further passed through reaction tubes containing a solid, such as silica gel, quartz sand, volcanic sand, or alumina which had been heated to  $900^\circ$ – $1100^\circ$  C. The solids selected are common in the crust of the earth. The reacted gas was absorbed in 3N aqueous ammonia in the cold, and then heated in a sealed bottle at  $75^\circ$  for 35 h. Further evaporation under reduced pressure removed ammonia and water. The residue was refluxed with HCl, and the hydrolysate was evaporated to dryness and the residue was quantitatively analysed for the different amino-acids obtained in the synthesis.

In further test of the thermal theory of biochemical origins Fox describes a step toward thermal polymerization of amino-acids and of the subsequent production therefrom of formed micro-particles in a geological kind of environment provided by a model of a hot dry lava bed.

These experiments are significant in the sense that they demonstrate that transformations from primordial gases to pre-cellular forms could occur in a matter of hours.—(*Nature*, 1964, 201, 335.)

### New Findings on the Orgueil Meteorite

The composition of extraterrestrial matter has always been a matter of scientific interest, and recent advances in analytical techniques have permitted intensive probing into the nature of meteorites. This has been particularly true in the case of carbonaceous meteorites. These stones have been proved to contain as much as 7% carbon in the form of hydrocarbons and other organic compounds strongly suggesting a biogenic origin. The case for biogenicity would be strengthened if presence of specific organic compounds directly related to life processes could be unequivocally established in the meteoritic material.

The meteorite on which intensive work is being carried on in this direction is the Orgueil meteorite. Stones of the Orgueil meteorite shower fell at about 8 p.m. on May 14, 1864, near Orgueil and Campsas in France and they have been kept well preserved ever since in different museums of the world.

As though to mark the centenary of the Orgueil meteorite fall, two papers of significance have appeared in recent issues of *Nature*.

The first by Hodgson and Baker (*Nature*, 1964, 201, 125) gives evidence for the presence of porphyrins as revealed by spectral, chromatographic and chemical tests on organic matter extracted from the meteorite material. The second by Nagy *et al.* (*Nature*, 1964, 201, 228) reports the finding of optical activity in the saponified organic matter isolated from the Orgueil meteorite. These results suggest a strong possibility of biogenic agencies in the origin of the organic matter of the Orgueil meteorite.—(*Nature*, 1964, 201, 125 and 228.)

### Ultraviolet Sensitivity of the Third 'Eye' of the Horseshoe Crab

An optical organ in the horseshoe crab (*Limulus*), the function of which has remained a mystery, has been found to be a receptor of ultraviolet radiation. This was reported recently by G. Wald and J. M. Krainin of Harvard University and the Marine Biological Laboratory in Woods Hole, Mass.

Most animals with eyes at the sides of their heads have a third "eye"—or several of them—in the middle. In vertebrates this median eye exists only as a pineal body within the brain; it is at the most a vestigial sense-organ. In *Limulus* and many other arthropods, however, the median eye takes the form of two ocelli, each of which has a lens and a retina. The retina has seemed too coarse-grained and the

lens too rudimentary to allow for true image formation. Exposing the ocellus to light was known to evoke an electrical response in the nerve fibres of the organ. There are 50 to 80 receptor cells in the retina and each receptor ends in a nerve fibre; the fibres fuse to form a single nerve that is connected to the brain.

Wald and Krainin measured the sensitivity of the ocellus and the much larger compound eye at various wavelengths by recording the electrical response to radiation of these wavelengths. They found that the sensitivity is concentrated in the near ultraviolet, with a major peak at 360 m $\mu$ . There is a secondary but much lower peak at 530 m $\mu$  about the same as the major peak of the compound eye. Apparently each of the peaks is connected with a different visual pigment.

The response of the compound eye continues as long as the stimulus light remains on, but the response of the ocellus falls back almost to zero soon after it is stimulated. This suggests that the ocellus is a receptor primarily concerned with signalling a sudden increase rather than a decrease, in ultraviolet illumination. It is not known what behavioural purpose the response serves in *Limulus*, but is known that in the water flea *Daphnia magna* behavioural patterns associated with vertical migration are governed by the ocelli and are particularly sensitive to violet and ultraviolet radiation.—(*Sci. Amer.*, April 1964.)

### Pod and Leaf Spot of Okra Caused by *Ascochyta abelmoschi* in Himachal Pradesh—A New Record in India

H. S. Sohi and S. L. Sharma of the Department of Agriculture, Section of Plant Pathology, Himachal Pradesh, Solan report that a severe epiphytetic of pod and leaf spot of okra (*Abelmoschus esculentus* Meenck) caused by *Ascochyta abelmoschi* Harter occurred on collections maintained at the Vegetable Research Station, Solan, Himachal Pradesh, during September, 1963. The disease appeared in the form of a few scattered spots on the leaves in the month of July, which rapidly increased in severity to affect all aerial parts of the plant. The disease was most severe in September and continued to develop till the crop was harvested in the month of October.

The disease was reported for the first time by Harter in 1913 from U.S.A. It has also been described from U.S.S.R., Bulgaria, Ceylon, Brazil and Japan. This is the first record of this disease in India.



# THE SCINTILLATION OF THE STARS

SIR C. V. RAMAN

## 1. INTRODUCTION

THE stars in the sky appear to us as mere specks of light having no visible extension. But they exhibit a remarkable feature, *viz.*, a noticeable fluctuation in their observed luminosity. The brightest stars also exhibit flashes of colour when they are located not too high up in the sky. This "twinkling" of the stars is a familiar phenomenon. Its real nature becomes clearer when by the aid of some simple optical device, *e.g.*, a mirror or a lens moved in appropriate fashion, the observer views the image of the star drawn out into a continuous circle of light. This method of observation reveals large and rapid fluctuations of brightness along the track of the moving image of the star. Striking changes in colour are also noticeable in the case of the brighter stars as thus examined. Observation of such stars through a prism which draws out their images into a spectrum of colours further reveals some highly interesting effects.

We are clearly concerned here with an atmospheric phenomenon. In other words, the scintillation arises as a consequence of the passage of the light from a star through the air before it reaches our eyes. But it is by no means easy to understand how such a tenuous medium as the atmosphere could give rise to the observed fluctuations of intensity. It is thus evident that scientific problems of great interest are presented to us by the observed effects. Astronomers are naturally interested in the scintillation of stars by reason of its relationship to the unsatisfactory atmospheric conditions which often interfere with their professional activities. An important aspect of the subject is the location in the atmosphere of the regions in which the disturbed conditions exist giving rise to the observed scintillation.

This brings the subject into close relationship with the science of meteorology. Finally, we are concerned with the problem in optical theory of determining how the propagation of the light of a star is modified by its passage through the disturbed layers and gives rise to what is actually observed.

The present communication is not a review article and it is not proposed to survey the published literature or to discuss in detail any particular aspect of the subject. The purpose of the author is to set out a general view of the field as it presents itself to him and in doing so to indicate the basis on which he feels it is possible to reach a clearer understanding of the observed phenomena.

## 2. THE THERMODYNAMICS OF THE ATMOSPHERE

The light from a star has to traverse the entire atmosphere before it reaches the eye of the observer. The path traversed is the full height of the atmosphere if the star be at the zenith and increases progressively to several times that value as the star goes down in the sky and approaches the horizon. It follows that no attempt to explain the scintillation of stars can claim acceptance which does not take into consideration the actual condition of the atmosphere of the earth at all levels and their influence on the propagation of the light before it reaches the observer.

In the year 1899, the French meteorologist Teisserenc De Bort announced the discovery made by him of the existence of what he called the "Isothermal Layer of the Atmosphere" in its higher levels. The great importance of this finding was appreciated by meteorologists and it is now recognised that the lower part of the atmosphere known as the troposphere and the upper part known as the stratosphere exhibit different structures

and play different roles in the thermodynamics of the air. Meteorologists have also given a special name, *viz.*, tropopause, to the layer of transition between the troposphere and the stratosphere. The basic difference between the troposphere and the stratosphere is that the former normally exhibits a progressive fall of temperature with height, whereas the latter can be considered as isothermal, at least in the regions not exceeding some twenty kilometres in height above the surface of the earth. Beyond this height, the density of the atmosphere becomes a small fraction of its value at sea-level.

The question naturally arises how this division of the atmosphere into two parts with a different thermal behaviour arises. The answer may be found in the processes by which the atmosphere periodically gains and loses heat. It is in the troposphere that the energy received as radiation from the sun and absorbed by the surface of the earth is carried upwards into the air as heat by convective processes. The upper limit of the troposphere may, therefore, be taken to be the level at which these convective processes cease to function. In the stratosphere, on the other hand, we are chiefly concerned with the circulation of the atmosphere on a global scale brought about by the unequal heating of the earth's surface in low and in high latitudes.

The explanation of the division of the atmosphere into two parts indicated above receives support from the actual facts of the case. In the first place, it is found that the rate of fall of temperature with the height—termed by the meteorologists as the lapse-rate—has approximately the same mean value at all heights in the troposphere and in all latitudes, *viz.*, 6° C. per kilometre. On the other hand, the height of the troposphere is found to depend very markedly on the latitude, being about 16 kilometres at the equator, about 11 kilometres in middle latitudes and dropping to about 6 kilometres at the poles. Further, it has been established

by regular soundings of the upper air that there are day-to-day and seasonal variations in the height of the tropopause, these being particularly marked in the middle latitudes. Indeed it is there found sometimes difficult to locate any well-marked discontinuity between the normal rate of temperature decrease occurring in the troposphere and the approximately isothermal distribution in the stratosphere. It is clear from the findings that the conditions in the layer of transition between the stratosphere and the troposphere are of a dynamic nature and far from being static.

### 3. THE OPTICS OF THE ATMOSPHERE

The atmosphere of the earth is a stratified medium in the sense that the refractive index of the air falls off progressively with height above sea-level in proportion to the diminishing density, but less quickly than the atmospheric pressure owing to the fall in temperature. The figures in Table I illustrate this for the wavelength  $\lambda = 5000$  Å and the standard U.S.A. atmosphere. They justify the remark made in the introduction that the atmosphere is a tenuous medium which, indeed, is very much in the nature of an understatement with reference to the higher levels.

TABLE I  
*Refractive index of dry air*

Height (Km.)	Pressure (mb.)	Temperature (° C.)	Refractive Index
0	1013	+15	1.000273
5	540	-17	1.000168
10	264	-50	1.000093
15	120	-56	1.000043
20	55	-56	1.000019

Accepting the proposition that the scintillation of the stars is a consequence of local variations in the refractive index of the atmosphere, we have to ask ourselves to answer the following questions. How do these variations arise? What is the number

cal magnitude of the variations? What is the measure of their extension in space? In what region or regions of the atmosphere do they appear? Finally, are they actually capable of producing the observed effects? We proceed to deal with these questions *seriatim*.

The refractive index of air is determined by its composition and by its pressure and temperature. The content of water-vapour included in it is, in the lower levels of the atmosphere, the variable part of the composition. For the sake of simplicity, we shall, in what follows, not consider the variations of composition explicitly. For a standard atmosphere, the pressure and the temperature are known as functions of the height above sea-level. In dealing with possible variations from these standard values, a certain measure of simplification is introduced by the well-known principle that any volume-element of air, whether it is in a state of rest or of motion, automatically takes up the pressure of its surroundings. Hence, the difference in the refractive indices of the element and its surroundings is determined by their respective absolute temperatures. It follows from this, that local variations of temperature play a specially important role in our present problem.

With these guiding principles in mind, we shall proceed to deal with the other questions raised above. The plane waves of light from a star have to travel through three distinct regions before they reach an observer. (1) The stratosphere, (2) the transition layer between the stratosphere and the troposphere, and (3) the troposphere. We may consider these in order.

As shown by the figures in Table I, the refractive index of the air in the stratosphere falls to very low values. Further, this region of the atmosphere may, at least as a first approximation, be considered as isothermal. We are, therefore, justified in assuming that the stratosphere does not play any role in the phenomena of scintillation, though

naturally it would contribute sensibly to the refraction and dispersion of the light reaching the earth from stars at a low altitude above the horizon.

As has already been remarked, the region of transition between the stratosphere and the troposphere is one of dynamic change in which air-masses differing in thermal behaviour are continually altering their locations. Hence, this is a region which, *prima facie*, should be capable of giving rise to the phenomenon of scintillation. We shall return to this later and meanwhile turn to the case of the troposphere.

Meteorologists usually subdivide the troposphere into three parts, the lower, the middle and the upper troposphere respectively, and have recognized that each of these divisions has its own special features. The lower troposphere is that most affected by heat transfer between the surface of the earth and the air and it is, therefore, the region of which the structure shows the largest variations due to the periodic heating and cooling of the ground. It is in this part of the troposphere also that the so-called temperature inversions make their appearance in certain circumstances. The middle and upper troposphere, on the other hand, are practically uninfluenced by the diurnal temperature variations and exhibit the normal rate of temperature decrease with height. While they do exhibit seasonal variations in temperature, these variations are brought about by relatively slow processes. Whether in these circumstances, the troposphere can play any role in the production of scintillations may well be questioned. We shall presently proceed to discuss this matter.

#### 4. THE ORIGIN OF THE SCINTILLATIONS

It is clear that the methods and ideas of geometrical optics cannot possibly lead us to any acceptable explanation of the phenomena of scintillation. Indeed, one might go further and say that they are entirely out of place in any problem concerning the

propagation of light in a medium of variable refractive index. This becomes evident when, adopting the language of wave-optics, we remark that a change of refractive index means an alteration in the rate of change of the phase of the waves as they advance through the medium and hence there arises the possibility of large changes of intensity being produced by interference when overlapping occurs of waves which have traversed slightly different paths in the medium. Considerations of this kind are wholly foreign to the concepts on which geometrical optics is based. On the other hand, they play an essential and highly successful role in explaining the observed phenomena in diverse cases investigated at various times by the present author and his collaborators. We may here mention particularly the phenomena observed when light waves traverse a transparent medium carrying ultrasonic waves.

The foregoing remarks indicate in a general way the lines on which an explanation could be sought of the phenomena of the scintillation of stars. Somewhere on the path of many kilometres which the light from a star has to travel, the wave-fronts pass through a disturbed region in traversing which retardations of phase are suffered which are unequal over the area of the wave-front, while the amplitudes remain unaltered. During the further propagation of the waves, the phase-changes transform themselves into amplitude-changes; in other words, the effect of the unequal retardations of phase higher up in the atmosphere manifest themselves as unequal intensities when the waves reach ground level.

In thus applying the ideas of wave-optics to determine the effect of the passage of light through an atmosphere of varying refractive index, a very great simplification is possible by reason of two characteristic features in the problem, viz., that the refractive index of the medium itself differs but little from unity, and that, further, any possible variations of

it would be themselves a small fraction of the difference between the index and unity. From this, it follows that if the waves traverse in succession, two regions in one of which the index is higher and in the other it is lower than the average index of the medium, the phase-changes produced by them would cancel out partly or wholly depending on their actual values. In other words, a medium in a turbulent state and in which the refractive index exhibits random fluctuations would behave in much the same way as one which is quite uniform and has the same average index everywhere. Only in those cases where the phase-changes produced are so large and so distributed that they do not cancel out completely would the waves emerge from the disturbed region exhibiting any observable consequences of their passage through it.

From the figures given in Table I, we may readily deduce the difference in optical path resulting from the passage of light through a column of air one metre thick which is at the same pressure as its surroundings but differs in temperature by one degree centigrade. The results of these calculations are shown in Table II.

TABLE II  
*Phase-change in wavelengths*

Height (Km.)	Pressure (mb.)	Temperature (° C.)	Phase-Change per metre per degree
0	1013	+15	1.69λ
5	540	-17	1.02λ
10	264	-50	0.7λ
15	120	-56	0.34λ
20	55	-56	0.15λ

##### 5. LOCATION OF THE DISTURBED REGIONS

The lowest part of the troposphere lying within the first five kilometres above the surface of the earth is the region in which the convective processes set up by alternate heating and cooling of the ground during day and night respectively are most evident. One might be inclined to infer from this that

the same region of the atmosphere would be principally responsible for the scintillations of the stars perceived by an observer at ground level. Against this presumption can be urged the following considerations. Actually, we are concerned with the condition of the atmosphere at night time and not during the day. The upwelling of the overheated air from the ground would have reached and passed its maximum before nightfall and the violent changes of temperature consequent thereon would to a large extent have been smoothed out by the adiabatic expansion of the rising air and the cooling resulting therefrom, as also by the mixing up of the masses of air at different temperatures by the process of eddy diffusion. There would, no doubt, be left over some residual differences of temperature, but the individual volume-elements exhibiting such differences might be expected to be of very moderate dimensions. As already explained, the phase-changes suffered by the wave-fronts of the light in passing through these layers of air would be more or less completely cancelled out by a process of averaging. Temperature inversions, if any are present, would not alter this situation, so long as the surfaces of equal average temperature and the surfaces of equal pressure everywhere run parallel to each other, hence also to the surfaces of equal average refractive index.

Similar considerations would apply and even more cogently in the case of the middle and upper parts of the troposphere. The existence of regular stratifications of temperature parallel to the stratifications of pressure in those regions makes it highly improbable that phase-changes of the nature and magnitude necessary for giving rise to scintillations could be produced by the passage of the light waves through those layers.

Thus, we are led by a process of exclusion to conclude that, at least ordinarily, the disturbed region which is responsible for the scintillations perceived by an observer at

ground level lies high up in the atmosphere, being in fact the region of transition between the stratosphere and the troposphere. It has already been remarked that this region is essentially dynamic in its origins. Unless the transition between the troposphere and the stratosphere is a sharply-defined geometric plane—and such a situation cannot reasonably be expected to exist or persist—a wave-front passing through it would suffer phase-changes varying from point to point over its area. The figures exhibited in Table II show that at that level, a transition layer only one metre thick and varying only by one degree centigrade over its area would produce phase-changes of the order of half a wavelength. This would suffice to produce large and readily observable changes of intensity over the area of the wave-front when it has travelled over a sufficiently long path below the tropopause.

It is, however, necessary to remark that disturbed regions of other kinds may also appear in other circumstances and give rise to noteworthy optical effects. Meteorologists are familiar with the idea that a boundary or relatively narrow transition zone must exist between opposing wind currents or contrasting air-masses, and they refer to such boundaries as *fronts*. They are formed when two air-masses meet which differ in temperature and in density. The conditions existing at these boundaries or transition zones would evidently be favourable for large variations of phase to manifest themselves when they are traversed by the waves of light.

## 6. THE CHARACTER OF THE SCINTILLATIONS

The ideas set forth above when developed in detail lead us to a clear understanding of the entire ensemble of phenomena related to the observed scintillation of the stars. The wave-fronts which emerge from the disturbed regions of the atmosphere and exhibit localised phase-changes may be analysed into groups of plane wave-trains travelling in

directions inclined at various angles to the original direction of propagation. The amplitudes of these wave-trains and their inclinations are determined by the magnitude of the phase-changes in the original wave-front and the areas over which they appear. As a consequence, the telescopic image of a star would be spread out over a finite range of angles. The light reaching down to the earth would also exhibit a pattern of interferences due to the overlapping of these wave-trains. The maxima and minima of intensity in this pattern would be the closer together, the larger the angles are between the interfering wave-fronts.

Since the region in the atmosphere at which the optical disturbances originate is at a high level, the interference pattern observed at the surface of the earth would necessarily exhibit a movement parallel to the surface as a result of the rotation of the earth about its axis. The intensity of the light reaching the observer would fluctuate as the interference pattern moves over his eyes. These fluctuations would be the more rapid, the closer together the maxima and minima are in the interference pattern. As has already been remarked, their spacing is determined by the magnitude of the disturbance to regular wave-propagation produced by the atmospheric conditions. A relationship thus emerges between the rapidity of the observed scintillations and the effect of atmospheric conditions on the telescopic appearance of the star.

Colour effects can arise in two different ways. Since the scintillations owe their origin to interference, colour may be expected to manifest itself by reason of the wavelength differences in the spectrum. Effects thus arising would however be inconspicuous unless the interferences are of low order.

Colour effects of a different nature are also possible. The light from a star suffers refraction and dispersion in traversing the atmosphere of the earth. The deviations thus arising increase with the zenith distance of the star. The dispersion is however quite small unless the zenith distance exceeds 45° of arc. When the dispersion exceeds a few seconds of arc, the interference patterns for the different parts of the spectrum would cease to coincide at any given instant, but would become identical or nearly so at successive instants determined by the zenith distance of the star and the rotation of the earth. Very striking colour effects would then be observable, especially in the case of the brighter stars.

#### SUMMARY

The scintillation of stars is explained as an interference effect which arises in the following manner. Plane waves of light from a star when passing through a disturbed region high up in the atmosphere suffer phase-changes but no changes of amplitude in their wave-fronts. At lower levels, the phase-changes are transformed into amplitude changes, in other words, interference patterns are formed. These patterns move over the surface of the earth by reason of its rotation about the polar axis. The fluctuations of intensity passing over the eye of the observer are perceived by him as scintillations. It is shown that in this way, the entire ensemble of phenomena related to the scintillation of stars receives a satisfactory explanation. Reasons are given for identifying the region in the atmosphere ordinarily responsible for the observed scintillations at ground level to be the tropopause, in other words, the region of transition between the stratosphere and the troposphere.

# LIMITATIONS ON THE USE OF ISOTOPES IN REACTION MECHANISMS\*

## Part II. Solvolytic and Oxidation Reactions

S. V. ANANTAKRISHNAN, P. S. RADHAKRISHNAMURTI AND H. JAYARAMAN

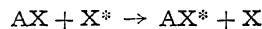
*Department of Chemistry, Madras Christian College, Tambaram*

TRACER studies have been extensively used in the study of reactions but they can be significant only where they assist in analysing specific features of the mechanism. Such results should be comparable with other modes and may be even misleading if isotopic distribution between reactants and products is sensitive to unexpected exchange reactions by alternative mechanisms. In the previous part (Part I, see *Curr. Sci.*, 1964, 33, 277) we examined some of the general features while here we present an analysis of some solvolytic and oxidation reactions where tracers have been used.

Ingold and his group<sup>1</sup> have made a comprehensive study of the hydrolysis of carboxylic esters and on this basis have classified the reaction into eight categories involving acyl-oxygen fission as well as alkyl-oxygen fission. Polanyi and Szabo<sup>2</sup> using isotopic oxygen as the tracer have shown that hydrolysis involves a C—O bond rupture. Kenyon<sup>3</sup> has provided evidence for alkyl-oxygen fission and our own work with branched chain alcoholic component of the esters has shown that this process has to be reckoned with.<sup>4</sup> However, Bender using O<sup>18</sup> as a tracer has suggested an alternative mechanism.<sup>5</sup> Bender's mechanism assumes an identical path for both hydrolysis and oxygen exchange. We have noticed that for a variety of carboxylic esters, the transition state is best represented by the topology of Laidler<sup>6</sup> where acyl-oxygen fission is involved.<sup>7</sup> Both alkyl-oxygen fission and carbonyl-oxygen exchange will require a different geometry so that the entropy term in the rate equation cannot be the same. Any inference drawn solely from the distribution of the oxygen isotope is of no use in relation to the mechanism of the process and does not justify an alternative to the current mechanisms. The loopholes in the interpretation are clearly revealed by Bender's attempt to explain away the absence of exchange in some esters and phthalides studied by him. Till fuller investigations using isotopic oxygen, isotopic carbon and isotopic hydrogen are all available, the S<sub>N</sub>i approach has to be preferred.

Solvolytic reactions in some complex compounds also bring out the limitations in our

present use of tracer studies. The general equation for an exchange can be given in the form



for both ligand exchange and central atom exchange. In the case of ligand exchange, it is assumed that there is a random distribution of isotopic ligands and the equilibrium rate is a measure of the lability of the central atom ligand bonds. While this is a convenient assumption, there is no *a priori* justification for this. The lability of the bonds in question has to be related to the geometry of the complex and the substitution mechanism. This need not be the same even for apparently similar complexes. Variations in repulsive pi-bonding in the transition state, differences in crystal field stabilisation between the ground state and the transition state and differences in the geometry of the transition state are all factors to be considered and isotopic substitution cannot give an adequate picture by itself. Differences in aquation rates between Co (III) and Cr (III) complexes reported by Bjerrum<sup>8</sup> and by King<sup>9</sup> are pointers where isotopic substitution may help in clarifying but not give a complete answer. Though comparable data on aquation may not be available in all cases, some idea can be had even by examining exchanges between ligands or central atoms. The considerable ranges among reported values for such processes when one examines the data for the different transition series<sup>10</sup> bring out clearly the limitations of tracer techniques alone as a means of testing a reaction mechanism. A fast reaction with cobalt complexes is a slow one with the analogous Rhodium complex. Ligand exchange with palladium is fast while that of platinum is slow enough to be measured. For the same element, appreciable differences for the same reaction is noticed for different valence states of the same element. It is only a combination of other methods with tracer techniques that can be expected to give the answer to such problems.

Extensive studies have been reported for oxidation reduction reactions in which isotopic tracer techniques have been used. A careful analysis shows that these give only a very limited information and do not help in the

\* Contribution to a Symposium on Radiation Chemistry by the Department of Atomic Energy held in March 1964.

choice of mechanism. We can take the oxidation of secondary alcohols and of aldehydes by chromic acid in aqueous systems. From the differences in the reaction rates of the normal compound and with the deuterated compound, it has been reported that in both reactions, the rate-determining step involves a rupture of the C—H bond of the secondary alcohol or aldehyde group. From the data on rate constants, while it is possible to infer that this particular bond is involved, the information cannot discriminate between the loss of the hydrogen as a proton or as a hydride ion nor does it indicate any clue to the postulated mechanism.<sup>11,12</sup> Our own findings from a fuller study of the reactions<sup>13-15</sup> requires an entirely different mechanism for the process. It can be noticed from Figs. 1 and 2

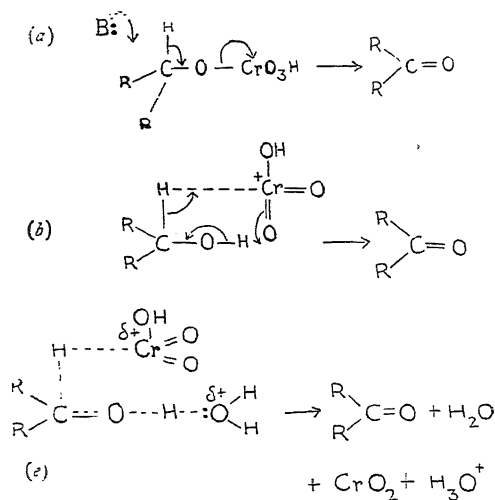


FIG. 1. (a) Westheimer's mechanism for secondary alcohols; (b) Roczek's mechanism; (c) our mechanism.

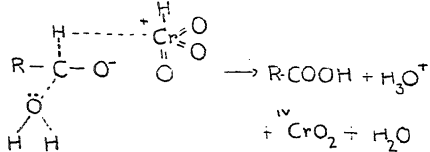


FIG. 2. Aldehyde oxidation: our mechanism.

that isotopic substitution does not enable us to distinguish between the alternative mechanisms. The limitations are further highlighted by the postulate of a similar mechanism for permanganate oxidations also<sup>16</sup> which cannot be justified on the basis of isotope effects.

Oxidations in inorganic systems in solutions are complicated by factors which limit the use of tracer techniques. Ion-pair formation and the influence of ionic strengths have to be reckoned with and there is no *a priori* reason why these should be identical for isotopes. In the absence of extended data at varying ionic strengths and possibly also in different solvents and solvent mixtures, the tracer technique can at best give some qualitative information about the possible path for an assumed configuration of the transition state but cannot be the final arbiter of mechanisms. These can be seen in such reactions as the role of anions in the Fe (III)-aquo ion and the iodide ion, Cr (III)-Co (III) reaction and the oxidation of thiosulphates with hydrogen peroxide.

Our thanks are due to the Council of Scientific and Industrial Research for a grant and for the award of a Senior Research Fellowship to one of us (H. J.).

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## THE LINE OF NARMADA-SON VALLEYS—A REVIEW

F. AHMAD

Department of Geology, Aligarh Muslim University, Aligarh

WEST<sup>1</sup> has recently drawn attention to the exceedingly interesting earth-feature that he refers to as the 'Narmada-Son Line'. He has pointed out that "It is remarkable....that the

same line should at one time mark the southern limit of the Vindhya and at a later time the northern limit of the Gondwanas"; also that, "It appears that the Narmada-Son Line may



have been a line of weakness from early times, with the areas to the north and south moving up and down relatively to each other along this line". Earlier, Auden<sup>2</sup> had arrived at similar conclusions and stated that "The Narmada rift is regarded as a major crustal feature of ancient origin, reflecting sub-crustal structure, and influencing the deposition and folding of the Vindhyan and the Gondwanas". The belt of country may partly also correspond to Fermor's<sup>3</sup> 'Satpura Protaxis'; and Ahmad,<sup>4</sup> recognizing that a cratonic area separated the two major Vindhyan basins of central and south India, called it the 'Deccan Craton'. Auden, it appears, also held the opinion that it was a zone of weakness when he stated that it was connected "with some primary weakness parallel to the Archæan grain". Thus, although West prefers to refer to it as a *line*, and points out that in place it separates by only a mile the Vindhyan beds to the north and the Gondwana beds to the south, it would, perhaps, be more appropriate to consider it as a narrow belt of country. Also, this belt does not appear strictly to correspond to the 'Narmada-Son Line', for the Son, in its lower course, cuts across the main Vindhyan basin, and the belt under consideration exists well to the south of this line.

West is, however, obviously correct in his emphasis that this belt has remained a positive area ever since the pre-Cambrian times. The feature is, nevertheless, by no means without parallel, for several similar belts and wider tracts have been identified in Africa; and the Southern Rhodesian Dome, the Katanga Plateau, and the Lunda Axis are, to mention a few, well-known examples. These have often been referred to as 'swells' and the 'Basin and Swell' structure has been paid particular attention by several geologists in Africa. Holmes<sup>5</sup> thought that these are produced "by differential warping on a regional scale, characteristically accompanied by marginal and internal faulting". Brock,<sup>6</sup> emphasising their significance in tectonism, pointed out that the Structural Map of Africa is "an exposition of basins and swells, that is, ups and downs within an elevated land-mass". These authors, thus, place the upwarped areas in the single category of 'swells'. Bucher,<sup>7</sup> however, classified them into 'swells' that are equidimensional, and 'welts' that show a "distinct linear development". West (personal communication) thinks that "the term 'swell' should be used for non-linear areas". Holmes<sup>8</sup> has given a map of Africa showing the swells and basins

known from that continent, and he, apparently, includes the welts and furrows as well.

Beetz,<sup>9</sup> describing the Lunda Axis, pointed out long ago that it "exists since pre-Cambrian times, and during later geological periods exerted an influence on the geological history of enormous areas both to the north and south of it". It is a comparatively narrow, elongated belt, and in Bucher's terminology this would, perhaps, be recognised as a typical 'welt'. Beetz, however, prefers to call it a 'swell'; and the term appears to be more popular. The Lunda Axis, obviously, appears to offer the closest parallel to West's 'Narmada-Son Line', the parallelism extending to the fact that on the two sides of this Lunda Axis beds equivalent to the Vindhyan were, apparently, simultaneously, deposited, just as on the two sides of the Narmada-Son Line the two major Vindhyan basins existed in India. It, then, seems but reasonable that West's 'Narmada-Son Line' should be recognised as a 'welt' (or a swell), howsoever narrow it may appear in certain parts of its length. Also, a cursory examination of the tectonics of this subcontinent would reveal that many such features exist in India as well. Thus, the Bundelkhand Granite area, the Eastern Ghats region, the 'Fox Ridge' (Ahmad<sup>10</sup>), the uplands along the south of the Godavari, the Nilgiri Plateau and its continuation across the Palghat Gap, and perhaps even the Aravalli Belt, all come immediately to the mind. A detailed study would, perhaps, reveal many others and may enable a map to be prepared, similar to that of Africa. These swells and basins (including welts and furrows) should, then, be given due recognition on any structural map of the country. Indeed, such a study is immediately called for, and is, perhaps, already overdue.

The author is grateful to Dr. W. D. West and Sri. S. C. Chakravarty for going through the manuscript and offering valuable comments.

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## LETTERS TO THE EDITOR

## ULTRASONIC STUDIES IN MIXTURES OF ELECTROLYTE SOLUTIONS

It was reported earlier by Subrahmanyam<sup>1</sup> *et al.* that evidence for complex formation could be had by the non-linear variation of velocity and compressibility with mole fraction of one of the components in aqueous electrolyte mixture at constant total molarity. They have reported that in the case of mixtures of Zinc and Cadmium halides with potassium halides non-linear variation both in velocity and adiabatic compressibility with mole fraction of Potassium halide and hence confirmed the formation of complexes in them. They have also shown that these mixtures are characterised by a positive excess compressibility, the result of which is explained as due to the decrease of the number of free ions. In a similar line the author has investigated in five aqueous electrolyte mixtures of Nickel chloride, Strontium chloride, Cupric chloride, Cobalt sulphate and Manganese chloride, with Cobalt chloride at constant molarity of 1 mole. The results are presented in the form of graphs.

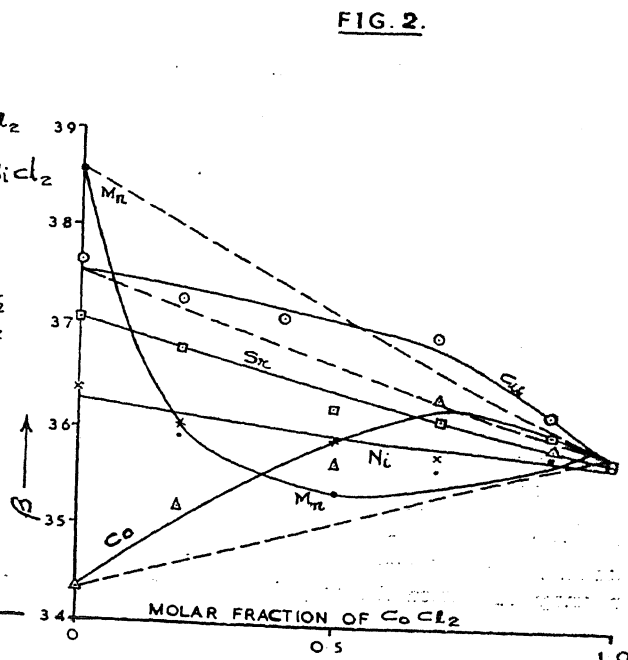
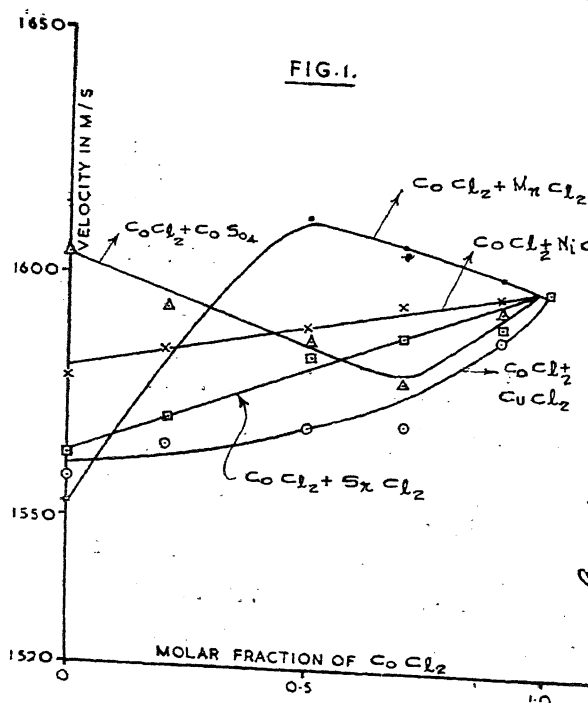
Mixtures of aqueous electrolyte solutions at different compositions are prepared by mixing

appropriate amounts of individual aqueous molar solutions. The velocities are determined by using a fixed path interferometer<sup>2</sup> with an accuracy of  $\pm 1$  m./sec. Densities are determined by the hydrostatic method correct to the third decimal place. All the mixtures are worked out at a fixed total molarity of 1 mole.

The velocity is found to vary linearly with mole fraction of  $\text{CoCl}_2$  in mixtures of  $\text{SrCl}_2$  and  $\text{NiCl}_2$  with  $\text{CoCl}_2$ . The velocity curve for  $\text{MnCl}_2 + \text{CoCl}_2$  is found to show a maximum value at a mole fraction of about 0.5 of  $\text{CoCl}_2$ . The curve for the mixture with  $\text{CoSO}_4$  shows a maximum at about 0.7 mole fraction and that with  $\text{CuCl}_2$  shows a non-linear variation.

The adiabatic compressibility curves show reverse features that are exhibited in the velocity behaviour of the mixtures.  $\text{SrCl}_2$  and  $\text{NiCl}_2$  mixtures with  $\text{CoCl}_2$  curves are found to be linear. Since these two mixtures are found to show a linear variation both in velocity and adiabatic compressibility they are considered as ideal mixtures.

The adiabatic compressibility curves of the other three mixtures as seen from Fig. 2 are non-



linear and hence they are considered as non-ideal mixtures.

The excess compressibility indicates a maximum positive value at about 0.6 and 0.65 mole fraction of  $\text{CoCl}_2$  in the case of mixtures of  $\text{CoSO}_4$  and  $\text{CuCl}_2$ . This indicates the formation of complex ions as they result in the decrease of the number of free ions with a consequent increase in compressibility.

Spectro-photometric evidence<sup>3,4</sup> shows that  $\text{CuCl}_2$  forms ions of the type  $\text{CuCl}^+$ ,  $\text{CuCl}_2^-$ ,  $\text{CuCl}_3^{2-}$  and  $\text{CuCl}_4^{3-}$  in aqueous solutions confirming the result arrived at from the compressibility behaviour.

The mixture  $\text{MnCl}_2 + \text{CoCl}_2$  is observed to show an excess compressibility which is negative and the curve indicates a minimum value at 0.45 mole fraction. This behaviour which is contrary to the behaviour observed in the case of the other two mixtures is yet to be explained.

The author expresses his thanks to the Council of Scientific and Industrial Research for giving financial assistance for this work.

Ultrasonic Res. M. SATYANARAYANA MURTY.  
Laboratories,

Physics Department,  
Andhra University,

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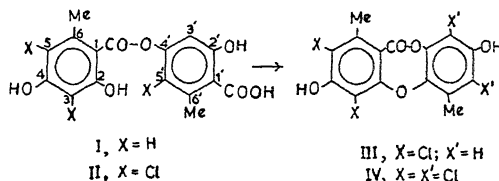
#### A NOTE ON THE SYNTHESIS OF DIPLOICIN METHYL ETHER

DEPSIDONES occur widely in lichens<sup>1</sup> as well as in fungi.<sup>2</sup> Of the depsidones that have been isolated so far, pannarin, gangaleoidin, vicanicin, diploicin, nidulin, noridulin and dechloronoridulin have been found to be chloro derivatives.<sup>2</sup> Various suggestions<sup>3-6</sup> have been made in the past for the biogenetic formation of a depsidone from a depside precursor. In the case of chlorodepsidones it is possible to visualise their evolution from simple depsides involving chlorination and ring closure in one operation. This is based on the analogy of the formation of thyroxine<sup>7</sup> from tyrosine using iodine. Chlorodepsidone formation can also be visualized as arising from a depside by chlorination to give a chlorodepside which can then undergo dehydro halogenation to give the

depsidone. The possibility of depsidone formation based on the latter suggestion has been studied now.

In the course of the work on the chlorination of depsides<sup>8</sup> it has been found that lecanoric acid (I) gives a trichloro derivative. The study of this product by fission proved its structure to be 3,5,5'-trichlorolecanoric acid (1'-carboxy-3,5,5'-trichloro-2,4,2'-trihydroxy-6,6'-dimethyl depside) (II). This was taken as a convenient starting material for the conversion into the depsidone, and was treated with copper bronze and pyridine at 35-37° for 7 days. The course of the reaction was followed by examining the I.R. spectrum. A study of the infra-red spectra of depsides and depsidones has shown that a peak at 1670-1690  $\text{cm}^{-1}$  is due to the presence of a chelated ester (COOR) in depsides whereas in depsidones owing to the absence of such a chelation the frequency of absorption of the ester grouping is markedly increased (1717-1730  $\text{cm}^{-1}$ ).<sup>9,10</sup> This was used for identification and comparison of products under study.

The reaction product was purified by paper chromatography (ascending) using Whatman 3 mm. paper using *n*-butanol saturated with ammonia as the solvent and a buffered solution of 2:6-dichloroquinonechlorimide as the developer. The impurities came as dark big streaks and a clean zone was obtained with  $R_f$  0.97 which when extracted and examined spectroscopically gave the characteristic carbonyl absorption of the depsidone. This product was insoluble in bicarbonate, obviously due to decarboxylation taking place during the reaction. It was methylated and further purified by ring opening to the hydroxy diphenyl ether carboxylic acid followed by its ring closure.<sup>11</sup> The depsidone (III) was further chlorinated to nor-diploicin (IV) and then completely methylated to the corresponding dimethyl ether which was once again purified by ring opening and ring closure.



The yield in the first stage of the conversion was very small, possibly due to the fission of the depside linkage during cyclisation. This was proved by the isolation of 5-chloro-orsellinic acid and 2-chloro-orsinol from the reaction products

In the subsequent stages of chlorination, methylation and other treatments the yields were good. Spectroscopic examination of the final product agreed well with an authentic sample of diploicin methyl ether.

Similarly, 3, 5, 5'-tribromolecanoric acid<sup>8</sup> and 5, 5'-dichloroatranorin<sup>8</sup> were also converted into the corresponding halogenated depsidones by this method.

The authors wish to express their thanks to the C.S.I.R., New Delhi, for a Junior Research Fellowship awarded to one of them (R. P.).

Dep't. of Chemistry, S. NEELAKANTAN.  
Delhi University, (Mrs.) R. PADMASANI.  
Delhi-6, April 27, 1964. T. R. SESHADRI.

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### THE KINETICS OF THE BROMINATION OF AROMATIC COMPOUNDS

Our present knowledge about the kinetics of the bromination of the aromatic nucleus is very limited. Although the over-all reaction between bromine and an aromatic substrate is generally known to be of the third order in several organic solvents, the exact mechanism of the process has not been clearly understood.<sup>1-4</sup> The precise rate constants and the Arrhenius parameters for various types of aromatic compounds have also not been determined so far. We have therefore undertaken in this laboratory a systematic study of the kinetics of the reaction in various non-aqueous media.

We have measured the rates of bromination of paradimethoxybenzene and anisole in dry acetic acid, and our new results are reported in

this communication. The reaction was carried out in iodine flasks of capacity 50 c.c., under the usual thermostatic conditions ( $\pm 0.05^\circ \text{C}$ ). The unreacted bromine present after various time intervals was estimated iodimetrically.

The experimental data for the reaction between bromine and paradimethoxybenzene in equimolar amounts were found to fit in best with the integrated form of the appropriate third-order equation

$$k_3 = \frac{1}{2t} \left\{ \frac{1}{(a-x)^2} - \frac{1}{a^2} \right\}.$$

The plot of  $1/(a-x)^2$  against  $t$  is a straight line with an intercept of  $1/a^2$ , for two different initial concentrations of the reactants (Fig. 1, plots A and B). The values of  $k_3$ , as obtained from the slopes of the lines, are 2.17 and 2.33 litre<sup>2</sup> mole<sup>-2</sup> sec.<sup>-1</sup> at  $30^\circ \text{C}$ . Additional evidence for the correctness of these values was obtained as follows. The rate of consumption of bromine was measured in a few experiments in which the initial concentration of the substrate was several times (10 to 40) larger than that of bromine. The data obtained fitted well with the second-order rate expression

$$k_2 = \frac{1}{t} \left\{ \frac{1}{(a-x)} - \frac{1}{a} \right\}$$

(Fig. 1 plots C, D, E). The values of  $k_2$

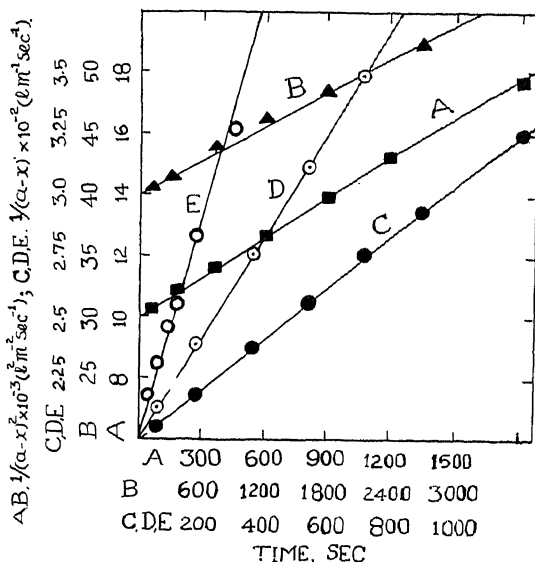


FIG. 1. A-B, Plot of  $1/(a-x)^2$  vs. time for equimolar initial concentration of reactants (bromine and paradimethoxybenzene). A, 0.01 M; B, 0.005 M. C-E, Plot of  $1/(a-x)$  vs. time; Initial Concentration of bromine is 0.005 M in each case; Initial concentrations of paradimethoxybenzene. C, 0.65 M; D, 0.10 M; E, 0.19 M. Temp.  $30^\circ \text{C}$ .

obtained from the slopes of these lines are 2.08, 2.08 and 2.40 litre<sup>2</sup> mole.<sup>-2</sup> sec.<sup>-1</sup> These are in very good agreement with the values obtained from straight lines A and B. These results clearly show that the over-all reaction is of the third order and the order with respect to bromine is two. In the kinetic studies on aromatic bromination published so far,<sup>2-5</sup> the experimental data have not been treated as we have done here. In most cases, only the total order of the reaction has been evaluated (and found to be three) by adopting the less rigorous "fractional-life method".<sup>6</sup>

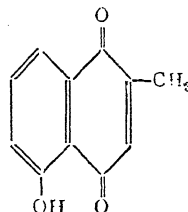
The bromination of anisole was also investigated on similar lines. The value of  $k_3$  was found to be 32.5 litre<sup>2</sup> mole.<sup>-2</sup> sec.<sup>-1</sup> Using these rate constants for anisole and paradimethoxybenzene along with the product analysis data reported by Stock and Brown,<sup>5</sup> and applying Holleman's product rule,<sup>7</sup> we deduced that the partial rate factor for the meta position for the methoxy group is 2.

The effect of temperature on the reaction was also studied and good Arrhenius plots were obtained. In the temperature range 20-40°C., the expressions for  $k_3$  were:  $k_3 = 1.86 \times 10^5 \exp. (-6900/RT)$  for paradimethoxybenzene; and  $k_3 = 1.94 \times 10^5 \exp. (-5200/RT)$  for anisole.

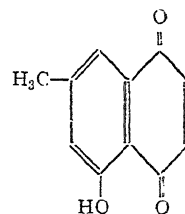
Work is being continued with more compounds such as orthodimethoxybenzene, paratolylmethyl ether, etc., and full details will be published elsewhere.

Physical Chemistry Dept., K. V. SESHADRI.  
University of Madras, R. GANESAN.  
Madras-25, May 22, 1964.

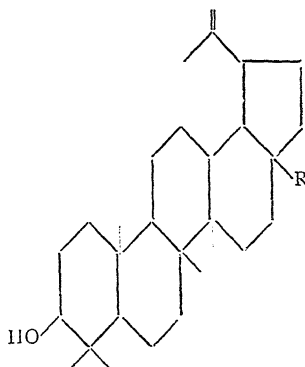
Recent investigations on *D. montana*<sup>6</sup> and *D. mollis*<sup>7</sup> revealed the presence of 2,2'-binaphthaquinones. The former contains all the three variants of the lupeol group of triterpenoids (III, IV and V) also.



I



II



III R=CH<sub>3</sub>

IV R=CH<sub>2</sub>OH

V R=COOH

During the course of our investigation of local heartwoods, five *Diospyros* species have been examined for their chemical constituents. Except *D. melanoxylon*,<sup>8</sup> the rest did not contain any naphthaquinones; but triterpenoids of the lupeol group have been encountered in good yield. Table I gives their occurrence.

TABLE I

<i>Diospyros</i> species	Lupeol (III) (%)	Betulin (IV) (%)	Betulinic acid (V) (%)	Other constituents
1. <i>D. melanoxylon</i>				
(a) bark	0.50	0.30	..	..
(b) sap wood	0.02	0.02	..	..
(c) ebony	0.02	0.02	0.01	..
2. <i>D. discolor</i>				
(a) fruit	..	0.05	0.05	β-Sitosterol
(b) wood	..	0.68	0.08	..
3. <i>D. Perigrina</i>				
(a) bark	..	..	2.5	..
(b) leaves	..	1.00	..	..
4. <i>D. haki</i>				
wood	..	..	..	β-Sitosterol
5. <i>D. chloroxylon</i>				
fruits	..	..	..	..

\* Under publication: *Chemistry of Diospyros Species* in N.I.S. Symposium on Natural Quinones.

### THE OCCURRENCE OF LUPEOL GROUP OF TRITERPENOID IN DIOSPYROS SPECIES

PLUMBAGIN (I) and 7-methyl juglone (II) have been isolated from a number of *Diospyros* species.<sup>1-4</sup> It has also been recorded that these are responsible for the poisonous and vesicant properties of *D. hebecarpa*<sup>5</sup> and other species.

Among the pentacyclic triterpenoids lupeol appears to occur most widely in plants; but rarely along with its two oxidation variants, betulin (IV) and betulinic acid (V). Now they have been noticed in *D. melanoxylon* also. It is interesting to note in this connection that frequently the oxidation state of 28-methyl group in lupeol, as well as in  $\alpha$  and  $\beta$ -amyrens, appears to go through  $\text{CH}_2\text{OH} \rightarrow \text{COOH}$ . The intermediate aldehyde stage is not frequently met with. It is only recently that oleanolic aldehyde has been isolated from *Heliabrevea chende*,<sup>8</sup> thus supplying the missing link in the oxygenation of the 28-methyl group.

The isolation of these components from the *Disopyros* species, recorded in Table I, has been made by extraction of the plant materials with petroleum ether (40-60°), ether and alcohol successively. These triterpenoids have been usually encountered in both petroleum ether and ether extracts. After the removal of the solvent, the extract concentrate was worked up by fractionation either by crystallisation or by chromatographic adsorption on alumina or both. In every case the triterpenoid was recrystallised, analysed and compared with authentic samples.

Betulinic acid (V)<sup>9</sup> crystallised from methanol as colourless needles, m.p. 298-300°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +5° (c, 1.08 in pyridine). (Found: C, 78.32; H, 10.60;  $\text{C}_{30}\text{H}_{48}\text{O}_3$  requires C, 78.94; H, 10.52%.) The methylbetulinate (diazomethane) crystallised from methanol as colourless needles, m.p. 220-22°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +3° (c, 1.06 in  $\text{CHCl}_3$ ). (Found: C, 79.41; H, 11.91;  $\text{C}_{31}\text{H}_{50}\text{O}_3$  requires C, 79.14; H, 10.64%.) The methyl ester acetate ( $\text{Ac}_2\text{O}$ -pyridine) crystallised from ethanol as colourless needles, m.p. 198-200°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +19° (c, 0.980 in  $\text{CHCl}_3$ ). (Found: C, 76.96; H, 9.92;  $\text{C}_{33}\text{H}_{52}\text{O}_4$  requires C, 77.32; H, 10.18%.) The acetyl betulinic acid ( $\text{Ac}_2\text{O}$ -pyridine) crystallised from methanol as colourless needles, m.p. 284-86°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +20° (c, 1.006 in  $\text{CHCl}_3$ ). (Found: C, 76.83; H, 11.20;  $\text{C}_{32}\text{H}_{50}\text{O}_4$  requires C, 77.11; H, 10.84%.)

Betulin (IV)<sup>10</sup> crystallised from methanol as colourless needles, m.p. 250-52°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +18° (c, 0.832 in  $\text{CHCl}_3$ ). (Found: C, 81.13; H, 11.70;  $\text{C}_{30}\text{H}_{50}\text{O}_2$  requires C, 81.45; H, 11.32%.) Betulin diacetate crystallised from ethanol as colourless shining long needles, m.p. 216-18°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +23° (c, 0.9620 in  $\text{CHCl}_3$ ). (Found: C, 77.57; H, 9.99;  $\text{C}_{34}\text{H}_{54}\text{O}_4$  requires C, 77.57; H, 10.27%.)

Lupeol (III)<sup>11</sup> crystallised from ethanol as colourless needles, m.p. 210-12°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +23.9° (c, 0.9680 in  $\text{CHCl}_3$ ). (Found: C, 84.9;

H, 12.14;  $\text{C}_{30}\text{H}_{50}\text{O}$  requires C, 84.5; H, 11.74%). Lupeol acetate ( $\text{Ac}_2\text{O}$ -pyridine) crystallised from ethanol as colourless needles, m.p. 210-12°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, +45° (c, 0.9869 in  $\text{CHCl}_3$ ). (Found: C, 81.74; H, 11.50;  $\text{C}_{32}\text{H}_{52}\text{O}_2$  requires C, 82.05; H, 11.11%.)

$\beta$ -Sitosierol<sup>12</sup> crystallised from methanol as colourless prisms, m.p. 136-37°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, -36° (c, 1.25 in  $\text{CHCl}_3$ ). (Found: C, 83.67; H, 11.96;  $\text{C}_{26}\text{H}_{50}\text{O}$  requires C, 84.04; H, 12.08%.)

$\beta$ -Sitosterol acetate crystallised from methanol as colourless needles, m.p. 126-27°; ( $\alpha$ )<sub>D</sub><sup>30</sup>, -36° (c, 1.46 in  $\text{CHCl}_3$ ). (Found: C, 81.45; H, 11.82;  $\text{C}_{31}\text{H}_{52}\text{O}_2$  requires C, 81.5; H, 11.54%.)

The authentic samples of lupeol, betulinic acid and betulin were secured by isolation from *Lanchocarpus blackii* (unpublished work of L. R. Row), *Oillenina indica*<sup>13</sup> and *D. melanoxylon*<sup>14</sup> respectively.

We are grateful to Mr. T. U. Chacko, formerly Head of the Botany Department, P. R. Government College, Kakinada, for the supply of *D. discolor* and *D. kaki*. Two of us (C. S. R. and T. S. R.) express their thanks to Council of Scientific and Industrial Research, New Delhi, for financial assistance.

Andhra University,  
Waltair,  
March 14, 1964.

L. RAMACHANDRA ROW.  
C. SANKARA RAO.  
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THE ROLE OF *MICROCOCCUS DEL.* IN  
ACID-FERMENTATION

An analysis of the relation of *M. trachynotus* to the vegetation of the same area of the forest, in the given forest, with a view to the determination of the place of its habitat, was carried out in the following way: in the same two areas of the forest, the relation for particular species of the vegetation to the external, physical, biological, and chemical conditions of the forest, and the relation of the species of the forest to the external, physical, biological, and chemical conditions of the forest, were determined. The results of the analysis are given in the following table.

shown in Table I that most of the cultures produced one or the other enzymes essential for the degradation of pectic substances. Micro-organisms which have previously been reported to be present in the rets of flax, hemp and other plants, and their significance in the process was discussed.

## Figure 1

Number of days from the beginning of the period of observation	Number of patients with a positive reaction
1st day of observation	12
2nd day of observation	29
3rd day of observation	6

One additional interest in the observation that most of the *M. thermophilum* sp. isolated were motile is because of their monotrichous flagellation. Further, further characterization of these cultures remains to be achieved, it was considered necessary to report this finding of considerable interest to microbiologists and celling technologists.

Formulation Tech. Lab., N. P. JAYASANKAR  
 Polymer Inst. No. 3, J. V. BHAT  
 Bangalore 42, May 4, 1964

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CHROMOSOME NUMBER AND SEX  
CHROMOSOME MECHANISM IN  
FIFTEEN SPECIES OF THE INDIAN  
PREYING MANTIDS

the Mantodea has remained quite an obscure group of insects up to the present day, especially from the cytological point of view. The total number of species of the praying mantids has been a preliminary cytological survey has already been made is only 56 (4). They belong to 13 out of a total of 32 subfamilies recognized by Wagner (5).

The chromosome number and sex chromosome mechanism in the present fifteen species of

TABLE I  
Chromosome number and sex chromosome mechanism in fifteen species of the Indian  
preying mantids

Species	Locality	Diploid number of chromosomes in male	Sex chromosome mechanism in male
*Subfamily PERLAMANTINÆ			
*1. <i>Amorphocelis indica</i> Giglio-Tos	.. Doon valley	33	X <sub>0</sub>
Subfamily EREMIAPHILINÆ			
*2. <i>Humbertiella ceylonica</i> Sauss	.. Doon valley	23	X <sub>0</sub>
*3. <i>Humbertiella</i> sp. (not <i>H. indica</i> or <i>H. septentrionalis</i> )	Chandigarh	31	X <sub>0</sub>
*4. <i>Didymocorypha</i> sp.	.. Chandigarh	17	X <sub>0</sub>
*Subfamily CALIRIDINÆ			
*5. <i>Leptomantis parva</i> Werner	.. Doon valley	39	X <sub>0</sub>
Subfamily MANTINÆ			
6. <i>Mantis religiosa</i> L.	.. Chandigarh	27	X <sub>1</sub> X <sub>2</sub> Y
7. <i>Hierodula ventralis</i> Giglio-Tos	.. Chandigarh	27	X <sub>1</sub> X <sub>2</sub> Y
8. <i>Hierodula tenuidentata</i> Sauss	.. Doon valley	27	X <sub>1</sub> X <sub>2</sub> Y
*9. <i>Haldwania liliputana</i> Beier	.. Chandigarh and Doon valley	15	X <sub>0</sub>
Subfamily HYMENOPODINÆ			
*10. <i>Eumantissa ornata</i> Werner	.. Doon valley	33	X <sub>0</sub>
*11. <i>Hestiasula brunneriana</i> Sauss	.. Doon valley	27	X <sub>0</sub>
*12. <i>Creobroter urbanus</i> (F.)	.. Chandigarh	27	X <sub>0</sub>
Subfamily VATINÆ			
13. <i>Aethalochroa ashmoliana</i> (Westw.) Genus <i>Cheddikulama</i> Henry	.. Chandigarh	29	X <sub>0</sub>
*14. <i>Cheddikulama</i> sp.	.. Doon valley	27	X <sub>1</sub> X <sub>2</sub> Y
Subfamily EMPUSINÆ			
*15. <i>Empusa spinosa</i> H. A. Krauss	.. Chandigarh	27	X <sub>0</sub>

\* Cytologically reported for the first time.

Indian preying mantids, belonging to seven subfamilies, have been determined from their male germ cells. These have been presented in Table I, arranging the species systematically after Giglio-Tos.<sup>5</sup>

The present report provides cytological data on eleven hitherto unstudied species of mantids, thus bringing the total of the cytologically known species to 67. This also adds two more subfamilies of mantids, the Perlamantinæ and the Caliridinæ, to the list of subfamilies for which cytological information is now available.

The detailed analysis of their male mitosis and meiosis will be published shortly.

I am deeply indebted to Professor G. P. Sharma for his helpful suggestions and laboratory facilities. Thanks are due to Dr. P. N. Chatterjee, Forest Research Institute, Dehra Dun, for hospitality and laboratory facilities during my stay in his laboratories. Species Nos. 3 and 6 of Table I were determined by Dr. James A. G. Rehn of the Academy of National Sciences of Philadelphia, and I am deeply indebted to him for the same.

Department of Zoology, MADAN LAL GUPTA.  
Panjab University,  
Chandigarh-3 (India), February 29, 1964.

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#### THE DEVELOPMENT OF THE RECTAL PAD IN *DYSDERCUS KOENIGI* (HEMIPTERA: PYRRHOCORIDÆ)

THE popular belief of the absence of the rectal pads or glands in Hemiptera has been contradicted recently by Bahadur.<sup>1</sup> So far as the author is aware, no attempt has been made to follow the sequence of development of the rectal pad.

In *Dysdercus koenigi*, the pad is in the form of a dorso-lateral patch on the rectum. It consists of large cells with conspicuous nuclei and dense cytoplasm in contrast to the reduced epithelium of the rest of the rectal wall. In a 8 days and 20 hours' old embryo of *Dysdercus*, the rectum, represented by the proctodæum, is seen as a blind invaginated sac, obviously ectodermal in origin. There is no differentiation of the rectal pad and the cells of the proctodæum have nuclei of 3.2  $\mu$  in diameter. As a result to active mitotic division, the size of the





Livers of *Tachysurus sona* from the commercial catches landed at Sasson dock, Bombay, were dissected out and weighed. The relationship between the weight of the liver and the length of the fish is given in Fig. 1. It can be

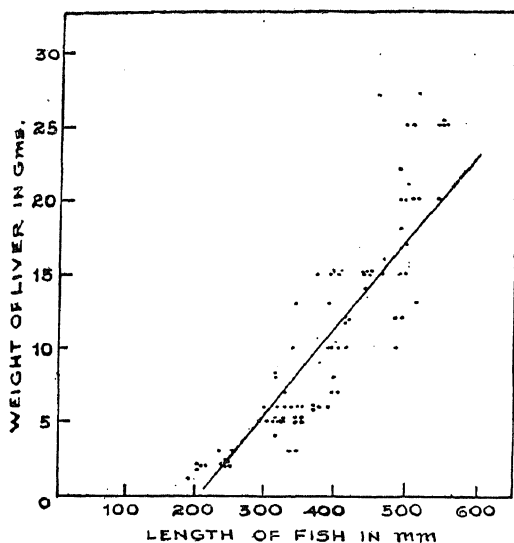


FIG. 1

seen from Fig. 1 that the liver contribution of various size-groups is quite substantial and on the basis of regression formula, the relationship between liver weight and body length was found to be  $Y = -22.216 + 0.082X$ , where  $Y$  is the weight of the liver and  $X$  is the size of the fish.

The oil from the liver was extracted by ether in a Soxhlet extractor and the oil percentage contained in the liver was calculated as ratio of liver weight. The percentage of oil from many samples was found to be on an average 8.95. The colour of the oil is dark brown and its melting-range  $30^{\circ}\text{C}$ . to  $50^{\circ}\text{C}$ .

For vitamin A estimation, Carr and Price's colorimetric reaction was used in a tintometer. Beckman quartz spectrophotometer was also used to measure the optical density, the vitamin A content was found to be 8,000 i.u., per gram of oil. It is therefore evident that the vitamin A potency of the cat-fish liver oil though less than that of the shark liver oil is certainly higher than the cod liver oil. Detailed investigations which are in progress will throw some more light on the importance and the value of this oil in future.

We are grateful to Dr. D. V. Bal for his continued interest in this work and to Dr. S. Z.

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Department of Zoology,  
Institute of Science,  
Bombay-1, February 8, 1964.

VIJAI D. SINGH.  
M. S. REGE.

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#### A NOTE ON THE FRESHWATER SPONGES OF POONA

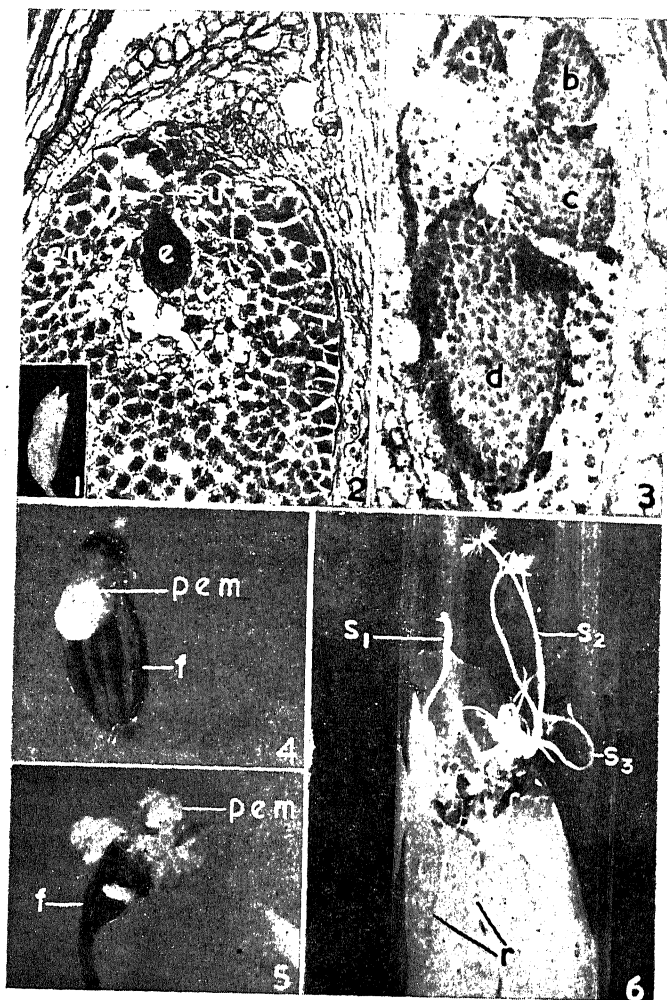
THERE has been no serious systematic survey work on the freshwater sponges of India since Annandale's (1911)<sup>3</sup> classical volume on this and related groups of freshwater organisms. But for his earlier<sup>1,2</sup> and subsequent notes<sup>4,5</sup> and to some extent brief notes by Geel<sup>6,7</sup> there is no other useful reference to the study of Indian freshwater sponges in the literature. Quite apart from their importance in the faunal complex of our country sponges provide excellent examples of cellular differentiation. Their power of reconstruction and regeneration coupled with their ability to develop a surprising variety of spicules under almost identical or even the same environmental conditions is too well known to need special emphasis. Conversely, different ecological environments do not necessarily provide with corresponding differences in the sponge fauna. Indian freshwater sponges have suffered from almost total neglect. It has been the aim of the present work to supply such a study as a part of wider exploration work on the freshwater fauna of Poona and adjoining areas. The collecting localities and areas explored for this study are designated earlier.<sup>11,12</sup> Since the form, shape and size of the sponges are unreliable characters taxonomy of the group is based entirely on the microscopic examination of skeletal, flesh or dermal and gemmule spicules. The present note reports the following four species of sponges recorded for the first time from this area. For brevity, detailed descrip-



embryonate. The ovaries implanted on BM, BM + IAA (1, 10 ppm.), or BM + autoclaved coconut milk (10%) produced only monoembryonate seeds. However, when ovaries were grown on BM + casein hydrolysate (100 and 500 ppm.), BM + yeast extract (100 and 500 ppm.), or BM + casein hydrolysate + yeast extract, in addition to the monoembryonate condition in 30%\* of the ovules, polyembryony was also induced in 10%\* of the ovules.

irregular embryonal mass which cleaved and/or budded (Fig. 3) within three weeks after inoculation resulting in 10-35 embryos. Owing to their vigorous growth the accessory embryos consume the endosperm so that the seed becomes exalbuminous. The polyembryonal mass proliferated through the pericarp in 10 to 16-week-old cultures (Figs. 4, 5).

Initially, the development of accessory embryos was irregular but the globular and heart-



FIGS. 1-6. Fig. 1. Ovary at the time of implanting on medium (7 days after pollination)  $\times 2.9$ . Fig. 2. Same, l.s. micropylar portion of mericarp showing cell lar endosperm and globular proembryo,  $\times 178$ . Fig. 3. 5-week-old culture (l.s. portion of mericarp), on BM + yeast extract (500 ppm), showing an embryonal mass with 4 embryos,  $\times 123$ . Figs. 4, 5. 12- and 15-week-old cultures on BM + casein hydrolysate (500 ppm) with polyembryonal masses proliferated through the pericarp, Fig. 4  $\times 4.5$ ; Fig. 5,  $\times 2.6$ . Fig. 6. 20-week-old culture on BM + casein hydrolysate (500 ppm) with multiple shoots;  $\times 1.1$ . (a to d, accessory embryos; e, embryo; en, endosperm; f, fruit; pem, polyembryonal mass; r, roots;  $s_1$  to  $s_3$ , shoots; su, suspensor.)

A developmental study of the fruits grown *in vitro* showed that the proembryo produced an shaped stages leading to the mature condition proceeded normally. The accessory embryos



follows then that further development should continue on normal lines to give us ultimately the double seedlings unless other factors interfere. Figures 2, 5 and 8 of Plate I (Rao, 1963) show clearly some of the stages mentioned above in adjacent archegonia of the same ovule. Though three neighbouring archegonia of the

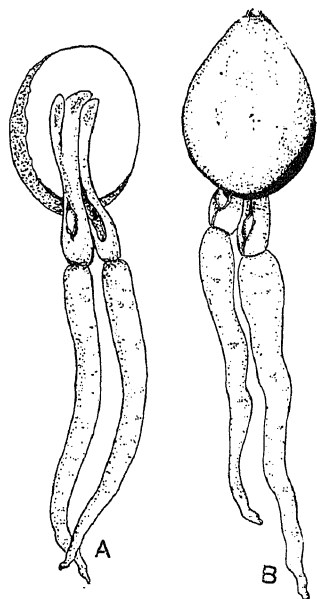


FIG. 2. A, Germinated seed cut lengthwise to show the two independent embryos,  $\times 1\frac{1}{2}$ . B, The same above uncut seed with the radicle and plumules between the base of the cotyledons,  $\times 1\frac{1}{2}$ .

same ovule showing the advanced stages of embryo development have been observed in some preparations, no case of three seedlings coming out of a seed has been noticed. However, the possibility is there for such a development.

"Jaya Nivas,"

L. N. RAO.

Gavipuram Extension,  
Bangalore-19, May 7, 1964.

\* Parts I and 2 of this series have been published in the *Journal of the Indian Botanical Society*, 1961, 40 (4) and 1963, 42 (2).

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## ON THE TISSUES IN THE PETALS OF *CAJANUS CAJAN* SPRENGL.

*Cajanus cajan* Sprengl. (Leguminosae; subfamily: Papilionatae) is an important honey plant cultivated annually during winter (May-June in Mysore) as a subordinate crop with certain cereals, all over the plains of India. The plant flowers during October-November and the flowering continues to occur along with seed formation, till March. Flowers are bright yellow, being thus attractive to the insect visitors and are formed in racemose clusters.

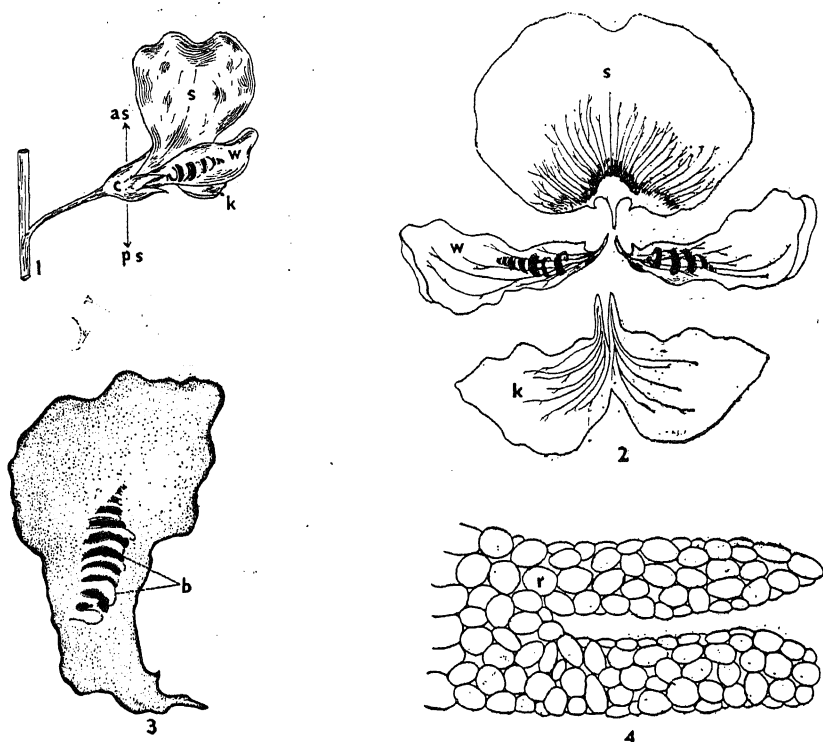
As in other members of Papilionatae the flower is zygomorphic (Fig. 1) and consists of (i) a gamosepalous calyx, (ii) five petal units, namely an anterior standard, a posterior boat-shaped 'keel' having two halves, and two wings, one each on the lateral side of the keel (Fig. 2).

Each of the above floral parts has been studied to locate the "nectariferous tissues". The study is based on preparations of petals boiled for about 2 minutes in water, stained by safranin and mounted in dilute glycerine.

The distal parts of all the different petal members are membranous and are composed of elongated rectangular cells (often one layer thick), but the basal parts are thicker and made up of meristematic tissues. In the standard and in the keel, these tissues are composed of rectangular cells elongated along the length of those floral parts, except for a small region of horizontally oriented rectangular cells on the abaxial side of the keel. But towards the base of the abaxial side of the wings (Fig. 3) are bands of spongy tissues consisting of rounded cells (Fig. 4) and when the wing is pressed under the cover glass, the bands separate from each other to present a clear picture of their organisation.

A search for the banded tissues at various stages of development of the flower has shown that in the early stages (before the petal comes out of calyx), the spongy tissue in the wing is uniform, and no banding occurs. During later stages, faint horizontal lines are seen, which become more prominent in a freshly open flower. The tissues are shrunk in the withered flowers.

The above spongy banded tissue on the abaxial side of the wings may possibly be the seat of nectar in *Cajanus cajan*. However, Fehling's test for sugar has given positive results for every part of the petals (standard, wings and keel). The situation of nectariferous tissues on the abaxial side of wings evidently provides an easy access to it by the honey bees.



FIGS. 1-4. Flower structure and banded tissue in *Cajanus cajan*. Fig. 1. Flower,  $\times 2$ . Fig. 2. Distribution of petal parts in the flower,  $\times 3.6$ . Fig. 3. Wing showing the position of banded tissues,  $\times 6.6$ . Fig. 4. Banded tissue (magnified),  $\times 100$ . (as, Anterior side; b, Bands of spongy tissue; c, Calyx; k, Keel; ps, Posterior side; r, rounded cells of spongy tissue; s, Standard; w, wings.

The authors are grateful to Prof. K. N. Kaul for his keen interest and encouragement. Their thanks are due to Mr. S. N. Srivastava, for carrying out the sugar test, and to Mr. J. P. Mull and Mr. K. Rehman for help in making the illustrations.

Palynology Laboratory,  
National Botanic Gardens,  
Lucknow, February 24, 1964.

P. K. K. NAIR.  
A. SEN (MRS.).

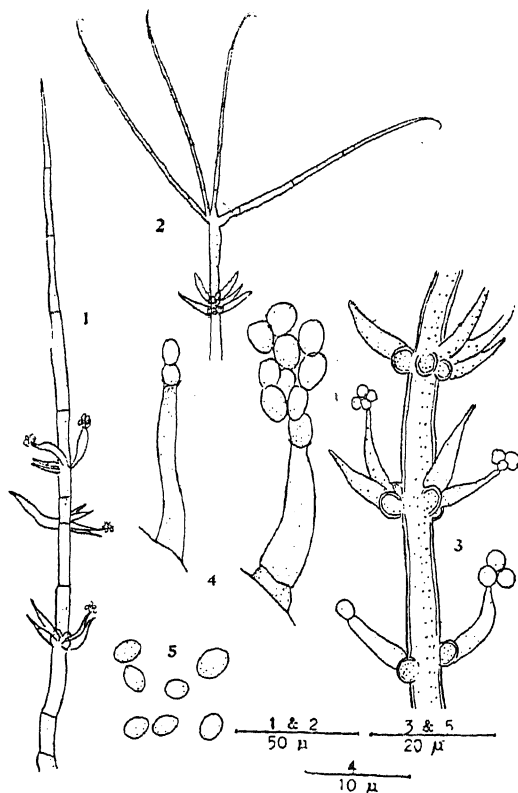
#### **GONYTRICHUM MACROCLADUM (SACC.) HUGHES—A NEW RECORD FROM HYDERABAD**

HUGHES (1951) working on fungi like *Stachyridium* Link., *Gonytrichum* Nees., *Mesobotrys* Sacc., *Chaetopsis* Grev., and *Chaetopsella* Hoenel., discussed the validity of the genus *Mesobotrys* and treated it to be congeneric with *Gonytrichum*. Consequently *M. macroclada* Sacc. and *M. fusca* Berk & Broom., have been disposed of as *Gonytrichum macrocladum* and *G. fuscum* respectively. In continuation of their studies on

Hyphomycetes of Hyderabad, the authors collected *G. macrocladum*, which forms the subject of the present communication.

#### *Gonytrichum macrocladum* (Sacc.) HUGHES

Olive-green black, velutinous, irregular colonies are produced by this fungus on the substratum, consisting of dark brown, thick-walled septate, branched  $1.5-4\mu$  broad creeping mycelium. Conidiophores arise singly from creeping mycelium all along their length. Conidiophores are simple or branched, dark brown at the base, with somewhat broader or pointed gradually towards apices,  $5-14$  septate, septa  $15-32\mu$  apart,  $220-450\mu$  long,  $4-14\mu$  broad at the base, up to  $3\mu$  broad at the apex,  $3-10$  phialides arise in verticills on conidiophores in groups of  $3-6$ . Phialides are long, cylindric, pointed or wide, subhyaline to dilute brown,  $8-26\mu$  long,  $4-7.5\mu$  broad at base, up to  $2\mu$  broad at apex, borne on a bulbous, dark-brown basal cell. Sometimes conidiophores are branched producing



(From V.V.C.B.L. No. 321)

FIGS. 1-5. Fig. 1. Unbranched conidiophore. Fig. 2. Part of the conidiophore with branches. Fig. 3. Conidiophore with verticills of phialides. Fig. 4. Phialides bearing conidia. Fig. 5. Conidia.

group of sterile branches, which are straight or coiled at their apices, measuring up to  $145\ \mu$  in length. Conidia are catenate, never forming simple or branched chains but in heads, oval to round, subhyaline to dilute brown, continuous,  $2.5-5\ \mu$  long,  $1.5-3\ \mu$  broad.

Collected on old unidentified woods from Pakhal (Warangal, A.P.) on 20-9-1963. Coll.: P. R. Herbarium hyderabadense V.V.C.B.L. No. 321.

We express our sincere thanks to Prof. M. R. Suxena, Department of Botany, Osmania University, and Dr. S. D. Satwalekar, Principal, Vivek Vardhini College, for facility and encouragement.

Department of Botany, S. S. KULKARNI.  
Vivek Vardhini College, DEV RAO.  
Hyderabad, A.P., India, December 21, 1963.

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### *CERCOSPORA JAMAICENSIS* CHUPP ON *DATURA STRAMONIUM* L. A NEW RECORD FOR INDIA

*Cercospora jamaicensis* is recorded on *Datura suaveolens* Humb. and *D. arborea* L. from Jamaica and Costa Rica. Another species, *Cercospora daturicola*, has been described on *Datura stramonium* L., *D. alba* L., and *Hyo-scymus niger* L. from Argentina, Caucasia, Oklahoma and China. Chiddarwar<sup>1</sup> described a species of *Pseudocercospora* on *Datura fastuosa* var. *alba* from Poona, India.

During September-October, 1963, a leaf-spot disease of *Datura stramonium* was observed at Kanpur. The disease was characterised by sub-circular, to irregular, scattered but often coalescing leaf spots, 1-11 mm. in diameter. In the early stage of the disease, the spots were buffy brown in colour but later they become olive brown on account of numerous fructifications. On microscopic examination, it was found that the conidiophores emerged mostly through stomata.

**Morphology of the fungus.**—Stromata  $15-49.3\ \mu$  in diameter, subglobose to irregular, cinnamon-buff in colour; compact conidiophores in fascicles of 7-30 or more (Fig. 1a), olive-buff, continuous to one septate, non-geniculate non-branched, straight to variously curved, irregular in width, tip usually conic,  $3.3-5.5 \times 17.5-59.1\ \mu$  (average  $4 \times 33\ \mu$ ); conidia sub-hyaline but olive-buff in group, narrowly obclavate-cylindric, base obconically truncate, tip round to conic, indistinctly 2-8 septate, not constricted at the septum, straight to mildly curved,  $2.2-4.4 \times 26.3-79.9\ \mu$  (average  $3.6 \times 56.2\ \mu$ ) (Fig. 1b).

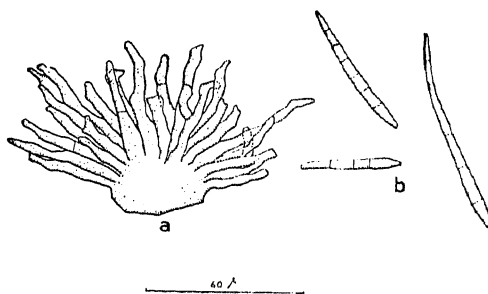


FIG. 1. Showing conidiophores and conidia of *Cercospora jamaicensis* Chupp. a, Conidiophores in a fascicle; b, Conidia.

In its diagnostic features, the fungus resembles *Cercospora jamaicensis* described by Chupp<sup>2</sup> but differs from it in having somewhat larger conidiophores, conidia and bigger stroma. Chupp gives a rather narrower width for the conidia



(2336) and a specimen of *Borreria verticillata* from Jamaica collected by the same collector in the year 1841. Since the corresponding specimens of the Indian collection. In the first of the above, this is the first record of *Borreria verticillata* in India.

Thanks are due to Mr. F. C. Doughty of the Commonwealth Mycological Institute, Kew Surrey, England, for confirming the identification (C.M.I. Research No. 1403116).

Section of the Plant Pathologist, R. S. MAMUN  
to Government, U.P., Kanpur, 207 001  
Kanpur, February 1, 1954. B. K. SINGH

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# **BORRERIA VERTICILLATA (LINN.) G.F.W. MEYER: A NEW RECORD FOR INDIA**

An interesting species of *Borreria* distinguished early from other related species particularly *B. stricta* Linn. f. by the presence of strongly verticillate leaves and by the almost spherical globose heads was collected from the neighbourhood of Agumbe in the Sagar District (Mysore State). A scrutiny of the collection material and the specimens were referred to *Borreria verticillata* (Linn.) G. F. W. Meyer, first collected from Jamaica and at present distributed in Tropical America and Africa. The specimens were checked with reference to a comparative photograph of *Spermatococcus verticillatus* in the *Linnean Collection* and confirmed on the basis of description and figure given by R. H. Smith and R. J. Howell. The present collection now extends the range of distribution of this species to India, particularly Western India. A brief description of this species is given below to facilitate its recognition in other parts of India, in view of the fact that the original references to this plant are not easily available.

*Borreria verticillata* (Linn.) G. F. W. Meyer,  
Pum. Fl. Esquadr. 30, 1816. *Spermatococcus  
verticillatus* Linn. Sp. 10, 162, 1759.

Perennial, much branched, squat caudex 10-15, 45-75 cm. high, branches tender at first, later becoming woody, faintly 4-angled, 6-10 mm

thick. Stems more glabrous. Leaves 2-3 cm. long, 1-2 cm. wide, ovate, verticillate, 9-10 at a node, minutely unispinose, sessile, or subsessile, pubescent, glabrous, chartaceous, 2-5-4 cm. long, 4-9 mm. broad, margins gently inrolled, apex acute, base attenuate, venation except for midrib distinct. Heads globose, 7-14 mm. across, terminal or subterminal, with 2-4 subtending, reflexed leaves. Flowers numerous, small, 3-2.5 mm. long, white. Calyx bicarinate, cotyledonous, about 1 mm. long with a cluster of bracteoid scales, and occasionally with 2 additional teeth in between. Corolla about 1.5 mm. long, corolla tube short, hardly .5 mm. long; corolla lobes 4, ovate, 3-veined. Stamens 4, about 1.5 mm. long, anthers dorsiflexed, sagittate, 1 mm. long. Ovary 2-lobed with one ovule in each, style 1.5 mm. long, stigma truncate, forked. Capsule 2-2.5 mm. long, 1 mm. broad, truncate, brownish, dehiscing ventrally from above, seeds 2, oblong, dark brown, glossy, minutely irregularly reticulate, ventrally grooved (Fig. 1).



FIG. 1. *Borreria verticillata*. Branches with details of flowers and fruits. (From top to bottom: flowers, calyx, corolla opened, flower with corolla removed, capsule and seed, dorsal and ventral views.)

Flowers almost throughout the year, especially between May and November, common on waste-

lands along the outskirts of forests in moist areas.

#### SPECIMENS STUDIED\*

Shimoga district (Mysore State): Agumbe, Sundara Raghavan 62421, 62781, 80672, 83250, 86365, 90379, 90405; Gajanur, Sundara Raghavan 74323; Tirthahalli, Sundara Raghavan 90088; Varahi forests near Hulical, Sundara Raghavan 80869, 83250; Yedur—Hulical route, Sundara Raghavan 90271 (BSI).

#### ACKNOWLEDGEMENTS

The author is indebted to Shri Seshagiri Rao Rolla, Regional Botanist, and Dr. A. S. Rao, Systematic Botanist, for valuable suggestions and kindly going through the manuscript and to Rev. Father Dr. H. Santapau, S.J., Director, Botanical Survey of India, for interest evinced in the work.

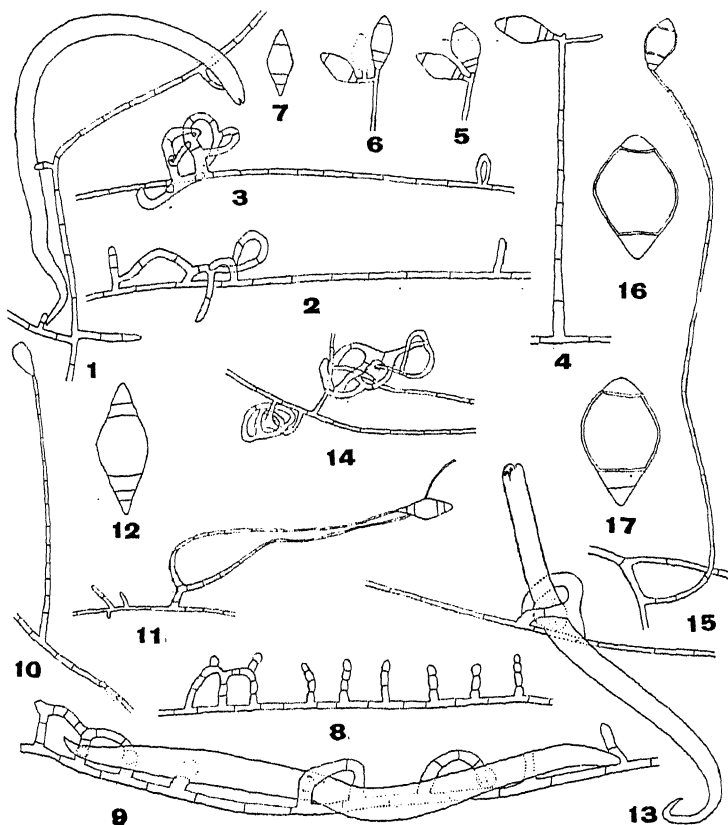
Botanical Survey of India, R. SUNDARA RAGHAVAN, Western Circle, Poona-1, February 7, 1964.

\* Specimens deposited in the Regional Herbarium, Western Circle, Botanical Survey of India, Poona-1.

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#### PRELIMINARY REPORT ON PREDACIOUS FUNGI IN INDIA

THE group of fungi which, in spite of their divergent taxonomic position, are united together by their typical habit of living on microscopic animals after capturing and killing them, are called predacious fungi. Apart from few exceptions taxonomically they fall into two main series, i.e., (a) the moniliales (hyphomycetes) and (b) the zoopagales (phycomycetes). The animals preyed upon are principally the protozoa and nematode worms though rotifers and



FIGS. 1-17. Figs. 1-7. *Dactylaria eudermata* Drechsler. Figs. 8-12. *Dactylella cinopaga* Drechsler. Figs. 13-17. *Dactylella* sp. (Figs. 1-8, 10, 11, 14 and 15,  $\times 177$ ; Fig. 13,  $\times 283$ ; Figs. 9, 12, 16 and 17,  $\times 433$ ),

even springtails are also captured and killed by some of these microfungi. As early as in 1874 Lohde<sup>1</sup> recorded the first predacious fungus in *Harposporium anguillulæ* and ever since considerable literature has accumulated as a result of the investigations in U.S.A., U.K. and continents which has been well reviewed by Drechsler<sup>2</sup> and Duddington.<sup>3,4</sup> The major bulk of the work done so far has been chiefly on the morphological side; the physiology and ecology being virtually left unexplored. Strikingly enough in contrast to the worldwide distribution and investigations of the predacious fungi there is almost no report of their occurrence in India so far.

The current investigation was undertaken to study the presence and distribution of predacious fungi principally in the agricultural and allied soils of West Bengal with a view to probe into the possibility of biological control of the destructive nematode diseases of crop plants by means of predacious fungi.

Soil samples from the surface layers along with the leaves and twigs at different decomposing stages were collected from the (1) Agriculture College Farm and Gardens, Haringhata, (2) Chagda Rice Research Station (Nadia), (3) House Gardens, Kalyani, (4) Cultivated lands in the Nadia district. Small portions of the material were sown on plates of sterile maize meal agar (half strength) and incubated at room temperature. Successful results were obtained from a few specimens of soil samples collected from the first three localities.

The inoculated plates except in case of No. 2 gave rise to a mixed culture of moulds, amœbæ and microscopic animals in which eelworms were plentiful and after 7-21 days of inoculation the eelworms were being preyed upon by fungi with slender, sparingly branched, septate hyphæ. The eelworms were trapped by the fungi with the help of sticky secretion, adhesive outgrowths, network and non-constricting rings which could be clearly seen under the microscope. Material No. 2 was however obtained in the moistened inoculum but could not be obtained successfully in culture.

From among the predacious fungi obtained three specimens belonging to the genera *Dactylella* and *Dactylaria* have been tentatively identified as:

1. *Dactylaria eudermata* Drechsler (Figs. 1-7).—Isolated from the Agriculture College Farm, Haringhata. Mycelium spreading, hyphæ hyaline, slender, branched. In presence of eelworms hyphæ give outgrowths (Figs. 1 and 2) or circular hyphal meshes (Fig. 3) which later are frequently compounded to form extensive network (Figs. 2 and 3). The eelworm is captured by adhesion (1) and entanglement. Conidiophores hyaline, erect, septate, bearing 1-3 conidia at the tip (Figs. 4-6). Conidia hyaline, ellipsoid or obovoid, broadly rounded at the tip, commonly 3-septate, the penultimate cell very large, somewhat tapered proximally (Figs. 4-7).

2. *Dactylella cinopaya* Drechsler (Figs. 8-12).—Isolated from the Chagda Rice Fields. Scanty mycelium. Hyphæ hyaline, septate, giving rise to columnar adhesive outgrowths, simple or branched. These outgrowths sometimes fuse with one another forming meshes and capture eelworms through adhesion (Figs. 8 and 9). Conidiophore hyaline, septate, erect, usually unbranched with a single conidium at the tip (Figs. 10 and 11). Conidia hyaline, spindle-shaped, 2-5 septate (Fig. 12).

3. *Dactylella* sp. (Figs. 13-17).—Isolated from the House Gardens, Kalyani. Mycelium spreading. Hyphæ slender, hyaline, septate and branched. In presence of eelworms hyphæ produce circular meshes compounded later to form extensive network (Figs. 13 and 14). Conidiophore hyaline, septate, erect with a single conidium at the tip (Fig. 15). Conidia hyaline, obovoid or broadly turbinate, 2-3 septate (Figs. 16 and 17).

Thanks are due to C.S.I.R. for the financial assistance and award of a Senior Research Fellowship to one of us (U.S.).

Kalyani University,  
West Bengal, India;  
May 4, 1964.

S. N. DAS-GUPTA.  
USHA SHOME.  
S. K. SHOME.

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## REVIEWS

*Advances in Virus Research* (Vol. 9). Edited by Kenneth M. Smith and Max A. Lauffer. (Academic Press, Inc., New York and London), 1963. Pp. viii + 312. Price \$11.50.

Two lively articles open this volume, the ninth of a series devoted to presenting reviews of recent developments in virology.

S. Fazekas de St. Groth's extensive essay on the neutralization of viruses, beginning with a quotation in Greek and ending with an appendix of mathematical models occupies the first 125 of this book's 312 pages. The author states at the outset that such a review should not merely make a "safe show of indecision" but rather should offer "as broad and clear a target as possible for future attack". While his article covering various aspects of antigen-antibody union, particularly with respect to influenza, and including a section containing practical advice for the practising serologist, is not always easy going, the use of such descriptive terms as "indefensible", "folly" and "measure of despair" makes for stimulating reading and amply fulfils the author's desire to avoid indecision.

Fazekas de St. Groth emphasizes the fact, so often overlooked that "the proper test of resistance to infection is experimental challenge". Serological tests can supply only indirect evidence bearing on resistance.

The author's statement that in retrospective epidemiology transient antibodies are of greater interest than the long-lived fails to take account of the varying requirements of different situations. It was only because of the persistence of haemagglutination-inhibiting antibody that Theiler in 1960 was able to show that the 1927-28 dengue epidemic in Greece was most likely due to the type 1 dengue virus.

Almost inevitable in a volume of this sort are the contradictory points of view expressed. Thus, Fazekas de St. Groth roundly condemns the use of any constant serum, variable virus test as a measure of serum antibody, while Porterfield in the following chapter on serological relations among arthropod-borne viruses points out the increased sensitivity with respect to cross-neutralization resulting in some instances from the use of whole serum incubated with serial dilutions of virus. Similarly, Porterfield states that in primary infections with arthropod-

borne viruses, the highest antibody titers detectable by any method are obtainable with the homologous virus strain, and then subsequently cites from his own work an instance of an anti-serum giving better neutralization with a heterologous virus than with homologous immunizing strain.

Referring to the antibody response, Porterfield comments that following yellow fever vaccination the "level of immunity... is not very high". It would seem desirable as pointed out by Fazekas de St. Groth, to cease employing immunity in this fashion with its implication that circulating antibody is the measure of immunity. Also debatable is Porterfield's view that the virus of Kyasanur Forest disease, because of its recent recognition, may be considered an example of "recent and considerable antigenic change". Such a view fails to give due importance to changes in ecologic factors which might permit an agent, active for years in extra-human hosts, to suddenly manifest itself by the production of illness in man.

The subsequent reviews provide solid information on their respective topics without provoking the reader in the same fashion as the first two. F. B. Brandon and I Wm. McLean Jr. of Parke Davis and Company discuss the adenoviruses, but their statement that "It seems reasonable to assume..." (that a polyvalent adenovirus vaccine) "could not be without value in a civilian population" smacks of product pushing and mars an otherwise excellent survey.

K. M. Smith's article succinctly brings up-to-date his chapter on the arthropod viruses in *The Viruses* (Burnet and Stanley, eds., Academic Press, 1959).

The chapter on ultracentrifugalization of plant viruses by Roy Markham provides a good introduction to the use of this instrument with any virus. Markham, however, traps himself in his use of the indirect phraseology so common in scientific writing. "Rather infrequently one comes across viruses which polymerize" he writes on page 252, while, three pages later he pens, "The polymerization of viruses occurs not infrequently". Which is it Dr. Markham?

In the final review concerning the rapidly evolving field of the classification of viruses of vertebrates, C. H. Andrewes discusses current ideas regarding grouping according to physical

and chemical properties and presents some of the characteristics of each group. As illustrated, however, by the addendum and note added in proof, this article by the time of its printing had already been superseded by later developments.

So long as volumes of this sort are available in libraries, there is no need for anyone save the specialist to purchase them. The principal value of such compendiums lies in their wonderful bibliographies.

DONALD E. CAREY, M.D.

**Special Ichthyology.** By G. V. Nikol'skii. (Translated from Russian and published by the Israel Program for Scientific Translations), 1961. Pp. 538. Price 88 shillings.

*Special Ichthyology* is intended to serve as a text-book on systematic Ichthyology for students in Universities and technical fishery colleges. With the increasing importance of Ichthyology as a subject taught in post-graduate classes, a suitable text-book is a keenly felt need for the teacher and the student alike. The majority of text-books available on the subject are either too general or too specialised that there is considerable difficulty experienced by the teacher and the taught alike to gather information on the subject. Published papers on systematic Ichthyology are so numerous and they differ so much in details that quite a lot of effort is required to understand the classification of fishes. The present book certainly serves the purpose of a text-book on the systematics of fishes, though not as a general text-book on Ichthyology, as suggested by the title of the book.

The classification of fishes is a very confusing subject-matter for discussion. Vast differences exist among the different systems of classification which have been proposed by eminent Ichthyologists. Much morphological information was made use of by Regan in revising the classification of teleosts. The classification of Berg (1940 and 1947) has met with general approval, but the creation of a large number of orders and classes makes it difficult to fit in the classification of fishes in the general scheme of classification of the vertebrata. The classification followed in the book under review is based mainly on the classification of Berg, as it is clearly stated in the preface, and where it deviates from the latter, the change is rather quite evident and calls for comment. The classification proposed by Berg recognises 12 classes, 10 subclasses and 114 orders, while the

present classification includes only 2 classes, 12 subclasses and 56 orders. The orders of fishes given by Berg agree with those given by Nikol'skii, but the higher categories lack agreement. This comparison also reveals a large number of omissions of familiar orders such as, Scopeliformes, Ateleopiformes, Polynemiformes, Symbranchiformes and Dactylopteriformes. It is stated in the 'Introduction' that the economic importance of the fishes is given considerable importance and this may very well have been the reason for the many omissions. The serious student of systematics is likely to search in vain for many familiar categories of fishes and such omissions are certainly defects in a treatise on systematic Ichthyology.

There is very little of reference to other systems of classification of fishes and so there is some difficulty experienced in understanding the classification proposed in this book in relation to other systems of classification of fishes. Essential anatomical details and the inter-relationships of the orders are mostly left out. Each order deals mainly with a few selected genera of economic importance and with the different aspects of their fisheries.

The literature is given in two series, an earlier part dealing with the publications in Russian and a latter part dealing with the publications in other languages, a practice that is not usually followed in scientific literature. Another deviation from the practice followed in science books in general is the effort made in different sections to discuss political ideologies in relation to fisheries development.

*Special Ichthyology* is a valuable treatise on the fish and fisheries of U.S.S.R. presented in a handy volume. It is a welcome addition to the literature on Ichthyology, but one is likely to feel the rather limited utility of the book as a reference on the classification of fishes because of the importance given to the commercial aspects of fishes in a discussion on systematics.

C. T. SAMUEL.

**Inorganic Complexes.** By Chr. Klixbüll Jørgensen. (Academic Press, London), 1963. Pp. 220. Price 42 sh.

One of the foremost men in the field of Inorganic Complexes, Dr. Jørgensen, is thinking aloud and thinking very fast. He takes the reader along the frontiers of this colourful field and this panoramic vision quite often carries him away and he liberally strews ideas and suggestions (fascinating especially when on central inert gas atoms), criticisms (many) and

predictions (quite a few). The book is certainly worth two guineas to any inorganic chemist. The co-ordinated character of the book is brought out in the index, which is in three parts: a brief section subtitled 'General Subjects', and two comprehensive lists entitled 'Central Atoms' and 'Ligands'. The bibliography has about 1,200 references, half of which is material published after 1960.

Except for the introduction and general conclusions, the other eight chapters are based on the type and nature of the ligands involved around various central atoms: they being divided into the ligands,  $H_2O$ ,  $OH$ ,  $O$ ;  $F$ ,  $Cl$ ,  $Br$ ,  $I$ ;  $N$ ;  $O$ ; amino-acid and  $NO$ ;  $S$ ; the miscellaneous low electronegativity ligands (e.g.,  $H$ ,  $P$ ,  $As$ , etc.); and intermetallic bonding and co-operative effects. Much of the factual outlook of the book is on spectroscopic data of the complexes, and for the theoretical views constant references are made to his earlier book *Orbitals in Atoms and Molecules* (Academic Press, 1962).

There are, unfortunately, many mistakes of language which is pardonable in an author to whom English is a foreign-tongue. These however, add force, if not grammar and idiom, to the expression of ideas.

G. B.

**A Monograph on Lac.** Editors: B. Mukhopadhyay and M. S. Muthana. (Published by Indian Lac Research Institute, Namkum, Ranchi, Bihar, India), 1962. Pp. 378. Price not given.

The Lac Research Institute in Namkum near Ranchi, India, ever since its establishment nearly forty years ago, has been doing considerable research work on lac, especially on the entomological and chemical sides. In recent years the Institute's activities have expanded to include all major aspects of lac research. The monograph under review brings together the accumulated knowledge gained by the workers in the various fields of lac research and presents the same in a useful and readable form.

Lac is perhaps the only resin of animal origin, being actually the secretion of the tiny insect *Laccifer lacca* Kerr. The most common host plants on which the insect subsists and produces lac are *palas*, *kusum*, *ber* and *khair*. Successful cultivation of lac demands a thorough knowledge not only of the insect, its bionomics, life-cycle, etc., but also of the numerous host plants, their ecology, incidence to pests, diseases and other pathological factors.

Lac cultivation in India is an age-old practice,

and even now it forms a major factor in the livelihood of a considerable population in the central and eastern states of the country. India produces nearly 70% of the world output of lac.

The monograph in the first few chapters describes the lac host plants, the lac insect, its bionomics and its life-cycle, the insect pests of the host plants and the predators of the lac insect, their control and eradication. Then comes the chapter on lac cultivation with special reference to improved methods practised in India. Then there are chapters on chemistry and technology of lac, lac resin, lac wax, their testing and grading, and their applications in various arts and crafts. The last two chapters are devoted to marketing and trade illustrated with statistical graphs, tables of imports, exports and prices, etc. Methods of sampling and testing are given as an appendix.

The chapters have been written by different authors who have been directly or indirectly connected with the Institute, but with special experience in the subjects of their choice. The editors have taken care to avoid repetitions as far as possible. The monograph is profusely illustrated and the information contained in it will no doubt be of use to all those who are interested in lac and its applications in science and industry.

The binding and get-up (as also the cover picture) might have been better, but probably they have been chosen to suit the moderate price which, however, has not been mentioned in the publication.

A. S. G.

#### Books Received

*Vapour Pressure of the Elements.* By A. N. Nesmeyanov. Translated and Edited by J. I. Carasso. (Infsearch Ltd., 207, Brondesbury Park, London N.W. 2; Distributors outside U.S.A. by: Cleaver Hume Press, 10-15 St. Martin Street, London W.C. 2), Pp. vi + 469. Price not given.

*An Introduction to Crystal Chemistry* (2nd Edition). By R. C. Evans. (Cambridge University Press, London N.W. 1), 1963. Pp. xii + 410. Price 52 sh. 6 d.

**A Monograph on Lac.** Edited by B. Mukhopadhyay and M. S. Muthana. (Indian Lac Research Institute, Namkum, Ranchi, Bihar), Pp. 378. Price not given.

*Physical Methods in Organic Chemistry.* Edited by J. C. P. Schwarz. (Oliver and Boyd, Tweddle Court, 14 High Street, Edinburgh-1), 1964. Pp. xi + 350. Price 50 sh.

*Theoretical and Experimental Biology* (Vol. 3)  
—*Patterns in the Balance of Nature and Related Problems in Qualitative Ecology*. By C. B. Williams. (Academic Press, Inc., London W. 1), 1964. Pp. vii + 324. Price 60 sh.

*Quantum Field Theory and the Manybody Problem*. By T. D. Schultz. (Gordon and Breach, Science Publishers, 150 Fifth Avenue, New York), 1964. Pp. viii + 150. Price Paperback 3.95, Clothbound \$ 6.95.

*Electrons, Atoms, Metals and Alloys* (3rd revised Edn.). By W. H. Rothery, 1963. Pp. 387. Price \$ 2.25. Dover.

*Thermodynamics and Fluid Mechanics Division for Mechanical Engineers* (Vol. 11) *Experiment Fluid Mechanics*. By P. Bradshaw. General Editor J. H. Horlock. (Pergamon Press, Headington Hill Hall, Oxford), Pp. xii + 210. Price 20 sh.

*Principles of Mechanics Simply Explained*. By M. Mott-Smith, 1963. Pp. x + 171. Price \$ 1.00. Dover.

*The Atomic Nucleus*. By M. Korsunsky, 1963. Pp. 412. Price \$ 2.00. Dover.

*Treatise on Light*. By C. Huygens, 1963. Pp. xii + 128. Price \$ 1.35. Dover.

*Electric Waves*. By H. Hertz, 1963. Pp. xv + 278. Price \$ 1.75. Dover.

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## SCIENCE NOTES AND NEWS

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### Inverse Compton Effect as a Possible Cause for Solar-Flare X-Radiation

The X-ray radiation of the Sun has been a subject of intense study in recent years and there are considerable data available on the radiation of both the quiet Sun ( $60 > \lambda > 5 \text{ \AA}$ ) and of solar flares (down to  $\lambda \sim 0.01 \text{ \AA}$ ). The cause of the solar X-radiation is still obscure, but calculations have been made on the assumption that it is of thermal origin and may be caused by the recombination radiation, bremsstrahlung, and radiation in selected lines of a very hot and optically thin plasma. However, the application of this theory to an analysis of the X-radiation of flares meets with some major difficulties, as for example unacceptably high temperatures and electron density to be assumed in the region of the flares.

J. Shklovsky of the Department of Astronomy, University of Moscow, suggests that the inverse Compton effect may be a probable cause for the X-radiation of solar flares. In Compton effect the X-ray photon colliding with an electron imparts part of its energy to the electron that is scattered in one direction, and itself reappears as a reduced quantum or softer photon in a different direction. Both energy and momentum are conserved in the process. In the inverse Compton effect it is envisaged that collisions between the relativistic electrons and photons result in the production of harder photons. Shklovsky supports his theory by deducing probable values for the energy of the relativistic electrons and their lifetime inside the region of the solar flare and showing the possi-

bility of such a process. It also explains the observed features of the flare X-radiation.

These calculations also show that the area of a flare will be a powerful source of synchrotron emission in the submillimetre and far infrared regions, which is worth-while testing. Further the inverse Compton effect may be a very efficient mechanism for the hard photon emission of some type of stars.—(*Nature*, 1964, 202, 275.)

### Laser Used in Atomic Absorption Spectroscopy

Use of a superpower laser for atomic absorption spectroscopy was announced by International Telephone and Telegraph Corporation, Fort Wayne, Indiana.

The new gigawatt pulse output laser is being used to evaporate materials for analysis of their composition. It is known, that the focused beam of the laser is capable of evaporating any known material. This allows atomic absorption spectroscopy to be extended to the analysis of refractory materials which defy conventional means of evaporation.

In operation, a hollow-cathode lamp generates the spectral lines of the element that it is desired to detect and measure. This light shines into a spectrometer consisting of a prism and an image dissector that measures the intensity of the various spectral lines of the light. The laser beam is focused on a sample of the material under analysis and evaporates a portion of it into the path of the light from the lamp.

If the material under analysis contains the element being measured, its vapor will selectively

absorb the lamp's spectral lines and the extent of the effect will be registered by the spectrometer. Atomic absorption spectroscopy can detect concentrations of one part per million of certain elements.—(*Jour. Frank. Inst.*, 1964, 277, 288.)

#### Signal Detection by Complex Spatial Filtering

Development of sophisticated optical devices which not only "see" but "read" may be speeded up due to an advance in optical spatial filtering technology reported by the University of Michigan's Institute of Science and Technology.

A complex filter is one that utilizes both the phase and amplitude information in a certain distribution of light. To date it has been fairly simple to use the amplitude information, but in order to use the phase information, the construction of phase plates was needed. A technique which simultaneously produces the required phase information and records it on ordinary photographic film without the use of auxiliary phase filters has been developed. Thus it is fairly easy to construct the required complex spatial filter for an arbitrary two-dimensional shape such as a letter or number.

In fact, with a simple modification, the processing system uses its own components to construct the required filter directly from the object to be recognized. It does not require a highly skilled operator. The device has the potential of detecting entire words or sentences from a printed page which might be recorded on microfilm. Thus it may be possible to use it as a reading machine, a translation machine, or for data reduction.

A strong feature of the technique employed in the experimental model is that no scanning is necessary. Therefore a word or object to be identified can be detected independently of its position on the printed page. The experimental device consists of a conventional coherent optical processing system, plus a modified arrangement of interferometers and a gas laser light source.—(*Jour. Frank. Inst.*, 1964, 277, 288.)

#### The Electron Microscope in Biology: EM 6 B

The remarkable improvement in recent years in the sectioning and selective staining of biological material for electron microscopy has called for a further improvement in resolving power. A recent AEI (Associated Electronic

Industries) development to meet this growing need is the EM 6 B, a high-resolution biological microscope.

The optical design of the EM 6 B is based on a new objective lens of short focal length (0.18 cm.) which has lowered to 2.2 Å the limit set to resolving power by diffraction and spherical aberration. A range of magnification 1000× to 250,000×, without change of pole pieces, is provided and magnification is selected by a single graduated control, the focus remaining substantially constant throughout. Point-to-point resolution of better than 5 Å has been consistently achieved on evaporated metal particles. This is a notable improvement over the 100 Å obtained with the EM 2 seventeen years ago. The ultimate limit of the power of the electron microscope believed to be in the region of one Angstrom unit, now seems much nearer, but will the last few Angstroms prove to be the most difficult?—(*AEI Engineering*, 1964, 4, No. 1.)

#### Use of a Microphotometer for Accurate Wavelength Measurement

In the measurement of spectral line profiles and shifts it often becomes necessary to measure separation of lines in a spectrum photograph with an accuracy to 0.001 mm. over a distance of 3 mm. As the profiles of the lines are asymmetrical the measurements cannot be made in the usual way with a travelling microscope, and very often a microphotometer has to be used. Even here experience shows that a conventional microphotometer will not be suitable for such accurate measurements.

A. D. Petford and G. Smith of the Oxford University Observatory describe a method of achieving the desired accuracy by incorporating a Ferranti moiré fringe device into the instrument. Calibration marks, derived from the moiré fringes produced when a grating rigidly attached to the microphotometer plate carriage passed across the face of a fixed grating, were recorded on the microphotometer chart. Using gratings of spacing 0.004 mm. and a simple phototransistor detecting system it was found possible to measure distances of up to 5 cm. on photographic plates with an accuracy to 0.001 mm. in terms of these calibration marks.—(*J. Sci. Insts.*, 1964, 41, 242.)



# RAMAN-EFFECT SYMPOSIUM AT FREUDENSTADT: I

## 1. INTRODUCTION

INVESTIGATORS keenly interested in Raman spectroscopy, both in its theoretical and practical aspects, are active at various centres in Germany and have been responsible for highly significant contributions to the subject. In the years 1955 and 1958, colloquia were held at the Technische Hochschule in Stuttgart to enable them to come together for useful discussions on their work. In the current year, the initiative for calling a Conference on a larger scale was taken by Professor Brandmüller at Bamberg and by Professor Goubeau at Stuttgart. A meeting was arranged from the 10th to the 13th of March 1964 and was held at Freudenstadt in the Black Forest region. Twenty-eight contributions figured on the programme. The majority of them were by German authors, but there were also some from other countries, notably Holland and France. The following has been prepared from the report of the Conference sent out from Stuttgart by Professor Goubeau: We begin with a brief report of a lecture by Dr. H. Haken from Stuttgart.

## 2. LASERS AND THE RAMAN EFFECT

The laser (light amplification by stimulated emission of radiation) is a development of the maser principle (maser = microwave amplification by stimulated emission of radiation) to the optical region. The essential parts of a maser are a total space resonator in which standing electromagnetic waves with discrete frequencies could be built up and an active material. This active material consists of atoms or molecules which can be brought to an excited state by means of a pumping process. By induced emission is built up a coherent electromagnetic field. While in the maser, at least in simple cases, only a single-oscillation frequency can be built up within the line breadth of an atomic transition, in the case of the laser, on account of the small wavelengths compared to the dimensions of the whole-space, there are many oscillations within a line breadth. Schawlow and Townes, therefore, suggested the method of further selecting the frequencies by the use of a Fabry-Perot arrangement. Thereby only oscillations which practically follow the axial direction have a great chance to be intensified.

The condition for the building up of a laser oscillation can be deduced as follows: The number of inductively emitted photons per second must be greater or equal to the number of

photons which leave the laser per second. The number per second of inductively emitted photons is proportional to the difference between the filling numbers of the two atomic levels and proportional to the number of the already existing photons, inversely proportional to the lifetime  $\tau$  of the atom and inversely proportional to the number of oscillations which can at all be emitted within the line-width  $\Delta\nu$ .

If we denote the lifetime of the concerned oscillation form in the cavity as  $T$ , and  $n$  the number of photons, then we should have the following inequality to hold:

$$\frac{\Delta N}{V} \frac{1}{\pi 8 \pi \nu^2 \Delta \nu} n \geq \frac{1}{T} n \quad (1)$$

from which the number of photons is deduced.

The selection of materials for the laser is determined, above all, by this inequality, which necessitates a small line-width of the optical transition. Examples of solids are the rare-earths, chromium and uranium, those which contain perturbation positions, for example, calcium fluoride, calcium tungstate, and also neodymium glasses, and chelates.

In order to fill up the upper levels, atoms are required with 3 or 4 levels. In the case of 4-level-laser, for example, the electron through external light excitation is lifted from the ground state to the highest state 4, it falls then to state 3, from there under emission of laser light to level 2, and finally it recombines again with the ground state. Another example of pumping process is constituted by gases in which also laser transitions are found, as for example, the mixture helium-neon. The helium carries here through collisions of the second kind, its excitation energy to the neon which then sends out the laser light. Further examples for gases of laser activity are the noble gases.

A very interesting type of lasers is the semiconducting diode, as for example, gallium-arsenic. Through suitable means the energy bands are so bent that on the one side the electrons are in the conduction band, while on the other side the corresponding holes are found in the valence band. On the introduction of an electric field, the electrons are carried into the region of the holes, and there they can recombine only radiatively. With a sufficiently high inversion density of electrons and holes an avalanche of light can build up.

Finally, we have to briefly touch upon the technique of the giant impulse of Hellwarth which

enables production of very strong laser lights of about 50 megawatts. For this we have to consider the laser process a little more closely. By the switching on of the exciting lamp through which the electrons are shifted to the excited level we get in time the inversion. If the inversion  $\Delta N$  is so great that the laser condition is fulfilled, the process of sending out laser light sets in. With a rotating mirror or with a Kerr cell one can attain the lifetime  $T$  of a laser wave reduced arbitrarily to any low value. If then the lifetime is made small, the laser activity can take place at a much higher inversion as per formula (1). If a mirror is now introduced so that the lifetime is suddenly made long then a light avalanche with appreciably higher intensity can start on account of the appreciably higher inversion.

Finally the special properties of laser light are briefly sketched :

- (1) Highly directional,
- (2) monochromatic,
- (3) high intensity within the line breadth,
- (4) spatial coherence,
- (5) coherence in time.

In the second part of the lecture the problem of induced Raman effect was taken up. If one irradiates a Raman-active material with a high laser impulse, then the Stokes, and even by low temperatures, the anti-Stokes lines could be observed. The Stokes lines appear only after going beyond a certain threshold value for the primary impulse, the anti-Stokes lines require then no further threshold value. The anti-Stokes light is produced in a very thin cone around the primary ray.

Then follows the description of the theory of Garmirer, Pandarese and Townes, in which the process is handled classically. In this, it is assumed that the polarisability of a molecule still depends on a molecular oscillation co-ordinate. In the equation for this molecular oscillation co-ordinate there arises a field term on the switching on of a high-frequency electric field, which depends quadratically on the applied field strength. Assuming in self-consistent manner that light consists of primary light. Stokes and anti-Stokes light we obtain, on account of non-linearity, a component for the restoring force which is in resonance with molecular oscillation. Through the oscillating dipole moment caused by the molecular oscillation, radiation will again be sent out.

In a more detailed discussion about the increase in intensity of the Stokes and anti-Stokes lines it is found that the anti-Stokes line

can be sent out only in a very thin cone of a definite aperture around the primary ray. One obtains further a calculation of the threshold condition. Finally, K. Grob has given a quantum theoretical treatment of the induced Raman emission. This rests on a generalised adiabatic approximation for the nuclear and electronic oscillations. It leads to a law of non-linear equations for electron and nuclear oscillations which are coupled to the light field. An iterative solution leads, under further special studies, just to the classical derivations of the authors referred to above. There are also other interesting generalisations.

*The Stimulated Raman Effect in Nitrobenzene* was reported on by Mme. Rivoire and Mr. R. Dupeyrat from Reims in France. It was excited with line  $\lambda$  6943 Å in a laser "giant-pulse". They obtained the lines corresponding to  $\sigma_1 = 1345 \text{ cm}^{-1}$  and  $2\sigma_1 = 2690 \text{ cm}^{-1}$  in stimulated emission, and many other Raman lines with fainter intensities. The lines  $\sigma_1$  and  $2\sigma_1$  show a threshold, above which their measured intensities were 12% and 4% respectively, in comparison with the intensity of the line 6943 Å. These lines were obtained only in the direction of the rays of the laser. In contrast, the anti-Stokes line  $\sigma_1 = -1345 \text{ cm}^{-1}$  came out with very weak intensity in an angle of about  $3^\circ$  with a ray of the laser. These different types of results and their dependence on direction are handled quantum-theoretically. Finally, the measurement of the line-widths of  $\sigma_1$  and  $2\sigma_1$ , performed with a Fabry-Perot interferometer, showed that these lines are narrower than  $0.14 \text{ cm}^{-1}$ .

### 3. THE RESONANCE RAMAN EFFECT

*The theoretical aspects of this subject* were dealt with by J. Behringer of Eichstatt. As the exciting frequency approaches the characteristic frequency of the electrons, the rise in intensity of the Raman spectra of multi-atomic molecules is not the same for all the frequencies. Although in many molecules the maximal rise of intensity was found to be due to the total symmetry of the vibration band, still there are cases where this is not so. To elucidate this finding, the theory which was developed till now for only diatomic molecules in semi-classical way for resonance Raman effect will now be generalised to cases of polyatomic molecules. For simplification, the nuclear displacements from the equilibrium position, those of the ground state of the electrons, and also the first excitation state in question, will be assumed to be subjected to a harmonic force law. The equilibrium configuration of the nucleus in the ground

state is a definite value. Therefore, the use of the help of mathematical integration in the calculation of the hyper surface of the excitation intensity on the basis of Frank-Condon principle seems to be the slope of the hyper surface of the potential energy with the symmetrical properties of the scattering integral of the incident wave function and of the eigenfunction of the scattered wave function for determining quantities for the excitation of the Resonance Raman Effect. In the case of the idealized conditions, one can obtain a quantitative understanding of the experimental results obtained so far.

Studies of the Resonance Raman Spectra of Azobenzene were reported by H. H. Kretschmann for a series of substituted azobenzene compounds: naphthalene, anthracene, 1,2-dichloronaphthalene, tetrachloronaphthalene, 1,2-dichloroanthracene, and the Raman spectra were compared with the spectra of the excitation wave length of the incident light in the line Hg  $\epsilon$ . As the wavelength of the incident light, a band of Azobenzene in the region of the resonance Raman spectra was observed.

The position of the resonance Raman spectra of azobenzene and some substituted azobenzene of azonaphthalene were found in the wavenumber range 1400-1440 cm<sup>-1</sup> and of the substituted hydroxy azonaphthalene in the range 1380-1400 cm<sup>-1</sup>.

The relative intensities of scattering coefficients of the observed lines from the resonance Raman spectra of azobenzene and substituted azobenzene are playing on the magnitude of the resonance Raman intensity, which for the resonance Raman spectra of different azobenzene compounds are proportional to the third power of  $\nu_0$ .

Also observed was the influence of the distance of the exciting line  $\epsilon$  from the resonance band of the longest wavelength of the excitation absorption band, and of the extinction coefficient of these bands on the magnitudes of the scattering coefficients. In addition, on the scattering of Azonaphthalene spectra, the resonance Raman spectra with Hg  $\epsilon$  and Hg  $\epsilon$ , the anti-symmetric scattering of lines of wave oscillation of different excitations were considered.

Results obtained so far show that the intensity  $I$  is:

$$I \sim \epsilon^2 \nu_0^{-2} \left( \frac{\nu_0 - \nu_0^0}{\nu_0} \right)^2 \left( \frac{\nu_0 - \nu_0^0}{\nu_0} \right)^2 \left( \frac{\nu_0 - \nu_0^0}{\nu_0} \right)^2$$

$\nu_0$  = wave-number of Raman line

$\nu_0^0$  = wave-number of the exciting line

$\nu_0^0$  = wave-number of the maximum of the electron absorption band (N-V transition)

$\gamma$  = damping constant which above the diffuse

relation with respect to half value width, HWH of the electron absorption band is known as  $\gamma$  HWH.

$\epsilon$  = extinction coefficient of these absorption band.

With the above relation, we have nearly achieved the original object of the investigation, that is, measuring the magnitude of a characteristic intensity to a particular oscillation. At the same time, it appears that other parameters, though it is not possible to name them, might well influence the magnitude of the resonance Raman intensity.

#### 4. MEASUREMENTS OF INTENSITY IN RAMAN SPECTRA

In the past communications made at Breitenstadt dealt with this subject. Their abstracts are reproduced here.

*Measurements of Intensity on Powdered Crystals* reported by H. Mocer of Munich. First of all, it was shown that it is possible to photoelectrically register strong and reproducibly Raman spectral spectra with the help of the help of a host of techniques and Kretschmann and Kretschmann lamps of high light density. The intensity of the apparatus was raised so much that the strength of the spectra was comparable to that obtained with liquid exposures. The small background permits of detection of the resonance Raman spectra of the exciting line up to about 10<sup>-4</sup> particularly with crystal lattice vibrations. Also, with small amounts of the substance, even up to a few mg, one could get completely satisfactory spectra. In order to eliminate completely absorption and fluorescence, however, it is immediately necessary to prepare the substance very carefully. In order to get scattering coefficients independent of the apparatus, it is necessary to evaluate the extinction coefficients which depend on the size of the particles and on the thickness and pressure and method of preparing the tablets. This is achieved by an experimental extrapolation to an infinitely small tablet, since in such a case neither the Raman nor the exciting radiation suffers extinction. A method of measurement has been given which with the help of this extrapolation and a special correction for refractive index, makes it possible to obtain simply and quickly the required scattering coefficient. In this way it has been possible to obtain scattering coefficients independent of the apparatus used, of about 100 Raman lines of substances, naphthalene, benzene acid, potassium nitrate, thallium nitrate, potassium sulphate, sodium bromide and tetra-

cyanaethylene relative to the line  $1382\text{ cm}^{-1}$  of naphthalene.

The question has been discussed of the influence of the pressure of tablet pressing on the intensity of Raman lines, as well as the question whether an external or an internal standard should be used. It has also been shown, that in the case of increasing thickness of the tablets of the irradiated substances, it is possible to get a constant ratio of intensities of the exciting radiation (exciter plus Rayleigh radiation) and those of Raman lines, a ratio independent of the parameters of the apparatus and of the way the sample has been got up. There remains the question open whether in this way the relation of Rayleigh to Raman intensities and thereby an absolute measure of the variation of polarisability, can be obtained.

*Raman Intensities of a few Inorganic Anions* by E. Steger of Dresden: By comparison of known data, it has been shown that one can obtain from scattering coefficients obtained in aqueous solutions the polarizability of the line  $\Delta\nu = 935\text{ cm}^{-1}$  of  $\text{ClO}_4^-$  under simplified correction, without the use of polarised irradiation. From existing values, we get complete systematic table of derivations of Binding-polarisability (in  $\text{\AA}^2$ ) of  $\text{XO}_4^-$  anion as:

P 0.94	S 1.35	Cl	} 1.73-2.74%
As 1.44	Se 1.96	Br	
		I	

The polarisability of  $\text{C} \equiv \text{N}^-$  bond rises almost to double the value on going over from ion  $\text{CN}^-$  to  $\text{SCN}^-$ ; the strengthening of the  $\text{CN}^-$  frequencies is, therefore, by the enhanced anisotropy, specially due to this effect. The exact calculation requires still more accurate measurements of the degree of depolarisation (they were obtained photographically by the use of Wollaston prism). Further more, the coefficients of transformation in normal co-ordinates should be correct to 2 decimal places. It is only in special cases that, at present, the Raman-intensity measurements can be judged as to their accuracy.

*Intensity Measurements of Raman Lines in Mixtures of  $\text{PSCl}_3$  with Tetrahalogenides of Elements of the IVth Group* by H. Gerding and C. C. Smitskamp, of Amsterdam: The results of investigations on mixtures of  $\text{POCl}_3$  with tetrahalogenides were reported.

We found for the P-O-valence frequency the following wave-numbers (in  $\text{cm}^{-1}$ ):

$\text{POCl}_3$  (pure) 1295; (in  $\text{CCl}_4$ ) 1300; (with  $\text{SiCl}_4$ ) 1301; with  $(\text{GeCl}_4)$  1301; (with  $\text{SnCl}_4$  Mol. ratio 1 : 2) 1299; and with  $\text{SnCl}_4$  Mol. ratio 2 : 1 in melt) 1210-1260.

For such mixtures of  $\text{PSCl}_3$  with tetrahalogenides of the IVth group, we found only very little displacements of the frequencies 540 and  $740\text{ cm}^{-1}$  from their values for pure  $\text{PSCl}_3$ .

A method has been reported for the determination of the comparison curve for the relation between intensity and registered deflection in a Hilger-Raman spectrometer and also thereby determining intensities of Raman lines.

In mixtures of  $\text{PSCl}_3$  and  $\text{CCl}_4$  we found an extraordinary behaviour of the intensity ratios for the lines of  $\text{PSCl}_3$  as also for those of  $\text{CCl}_4$  at the following concentrations:

25 Mol. % and 50-60 Mol. %  $\text{PSCl}_3$ .

By distilling these solutions nothing particular was obtained. With mixtures of  $\text{PSCl}_3$  with  $\text{GeCl}_4$  we found also an unusual intensity ratio at 25-33 Mol. %  $\text{PSCl}_3$  and 50 to 60 Mol. %  $\text{PSCl}_3$ ; there was nothing particular to notice in the distillation. In the mixtures of  $\text{PSCl}_3$  with  $\text{SiCl}_4$  we found extreme values of intensity ratios by about 30 to 35 at 50 Mol. %  $\text{PSCl}_3$ . There we obtained, at nearly constant temperature ( $86.5^\circ\text{C}$ ), a principal fraction in the distillation with 35%  $\text{PSCl}_3$  and 65%  $\text{SiCl}_4$  in the distillate. Finally, we found in mixtures of  $\text{SnCl}_4$  with  $\text{PSCl}_3$  for intensity ratios extremal values at 25-33, 56-60 and 80-90 Mol. %  $\text{PSCl}_3$ . Here, too, appeared a nearly constant boiling fraction at  $117.7-118.5^\circ\text{C}$ . which contained 57 Mol. %  $\text{PSCl}_3$ . Such compositions are found also in mixtures of  $\text{PS} (\text{C}_6\text{H}_5)_3$  with  $\text{SnCl}_4$ , about which Prof. Jellinek had mentioned, under reservations, that under high frequency titration extremal values are found. The extremal values found by us would lead us to suspect an interaction in the solution.

*Measurements of Polarisation and Intensity of Raman Lines in Solutions*, by R. Mecke and E. Seitz in Freiburg. In solution systems of tetrachloride of carbon in benzene, chlorobenzene and benzonitrile, very careful investigations have been made to find out to what extent the polarisation measurements are dependent on the concentration of the solutions and influence of the apparatus, of the vessel, the course of the rays, etc. It was found that there was no influence of the solvent in the whole range of solution till the pure liquid stage, based on careful measurements. The corrections suggested by Rank, Bernstein, Allen, etc., were checked, especially that referring to refractive indices. Here too there was good agreement. These substances can therefore be used as internal standards for calibrating polarisation measurements.

(To be continued)

# MINERAL NUTRITION AND NITROGEN FIXATION IN GROUNDNUT

S. GOPALAKRISHNAN, P. N. RAJU AND N. RAJAGOPALAN

University Botany Laboratory, Madras-5

THE effects of several mineral elements known to influence nodule formation and nitrogen fixation by legumes and their associated rhizobia have been described by Hallsworth.<sup>1</sup> The stimulation of symbiosis by small amounts of combined nitrogen and decreases in fixation with increasing rates of fertilizer nitrogen have been described.<sup>2-4</sup> The inhibitory effects of combined nitrogen on symbiosis were ascribed to the effects on the structure of nodules,<sup>5</sup> to reduction in cellular sugar content,<sup>6</sup> to the tying up of the plant carbohydrate by the added nitrogen and the consequent reduction in the rhizosphere excretion of bacterial infection factors<sup>7</sup> or to internal effects deriving from a high level of nitrogen in the plant.<sup>8</sup>

Stimulation of symbiosis by small amounts of combined nitrogen has been ascribed to increased growth of roots, the formation of more infection sites as well as haemoglobin in root nodules<sup>7</sup> while the symbiotic response to combined nitrogen appeared to be influenced by the time of its application during plant growth and the season,<sup>9</sup> the pH of the medium<sup>10-11</sup> and growth temperatures.<sup>12-13</sup>

nitrogen as  $\text{NO}_3/\text{acre}$ ) in field plots. Deficiency symptoms due to lack of Mg were also commonly observed along with those due to nitrogen. Pale yellow chlorosis, red stems and reduced plant growth characterized N-deficiency and marked interveinal chlorosis of the foliage was observed in the absence of Mg.<sup>14</sup> Fe-deficiency led to very stunted growth and chlorosis and drying up and dropping of older leaves.<sup>14-18</sup> Mg and Fe may, however, influence the competitive uptake of molecular and combined nitrogen by the nodulated legume since Mg-deficiency reduces carbohydrate production, leads to smaller protein content and small size of nodules<sup>4</sup> and cytological abnormalities in rhizobia,<sup>17</sup> while Fe-deficiency results in decreased protein synthesis.<sup>18-19</sup>

This communication, therefore, describes some effects due to  $\text{N}_2$ , Mg and Fe on N-fixation and haemoglobin content of root nodules of *Arachis hypogaea*. Using an effective *Rhizobium* (R4), from the same host, the symbiotic response to added nitrate nitrogen (as  $\text{NaNO}_3$ ) at zero, low (25 ppm) and high (150 ppm) applications

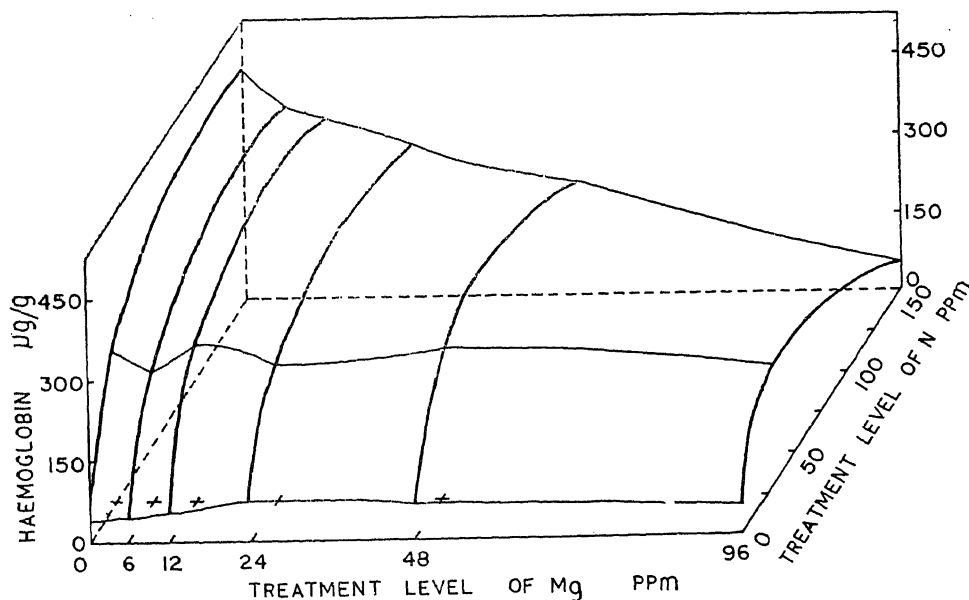


FIG. 1a. The influence of magnesium nutrition at nil, low and high levels of nitrate nitrogen on haemoglobin content of nodules.

Application of fertilizer nitrogen at high levels (120 lb. nitrogen as  $\text{NO}_3/\text{acre}$ ) to *Arachis hypogaea* have shown no significant yield responses than were obtained at low levels (30 lb.

were compared in sterilized sand cultures at treatment levels of Mg (0, 6, 12, 24, 46 and 96 ppm as  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ) and Fe (0, 5, 10, 25, 50 and 100 p.p.m. as  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ ).

As shown in Fig. 1 *a*, the hæmoglobin content of root nodules increase at low levels of applied nitrate nitrogen (25 ppm) compared to those that did not receive nitrate. Although the

hæmoglobin content of nodules even at 150 p.p.m. of added nitrogen were comparable to those obtained with low nitrogen (25 ppm), this was so only at the threshold levels of application

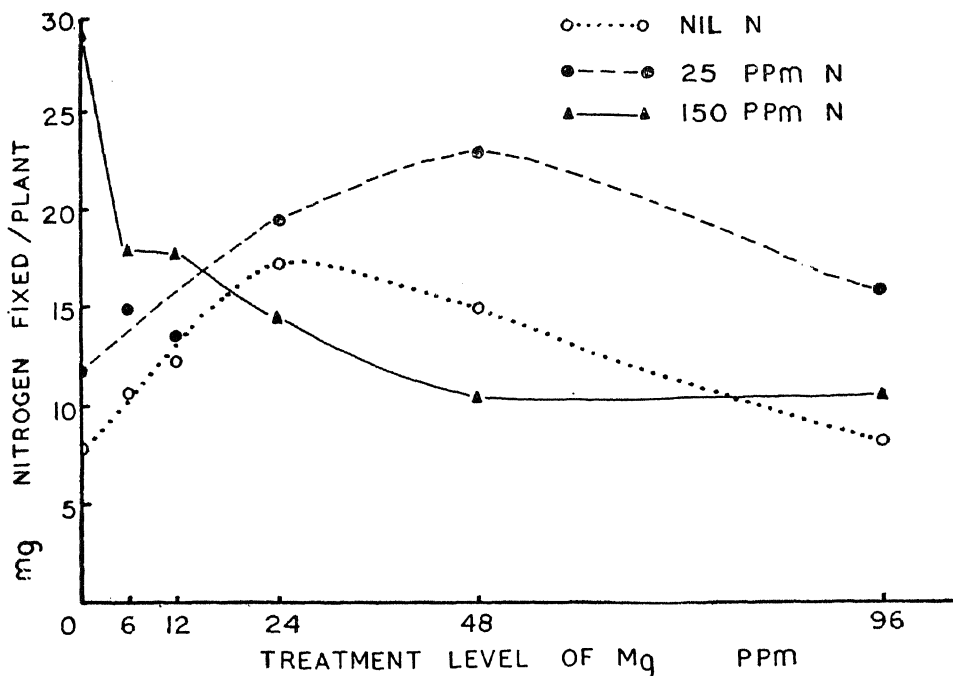


FIG. 1 *b*. The influence of magnesium nutrition at nil, low and high levels of nitrate nitrogen on nitrogen fixation.

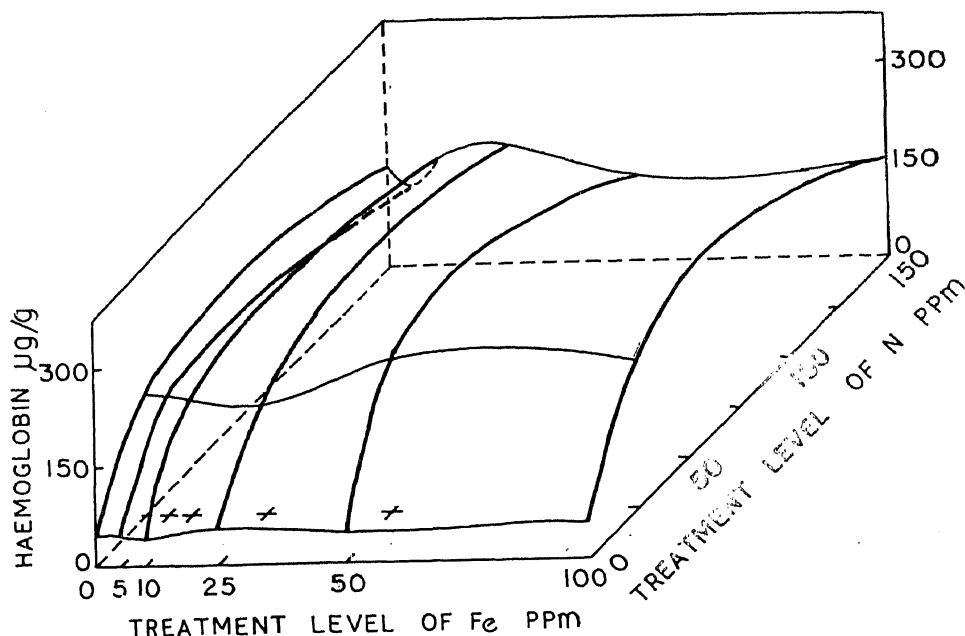


FIG. 2 *a*. The influence of iron nutrition at nil, low and high levels of nitrate nitrogen on hæmoglobin content of nodules.



## WATER VAPOUR IN THE ATMOSPHERE OVER INDIA NEAR THE GROUND

K. RAGHAVAN

Meteorological Office, Poona

## INTRODUCTION

**W**ATER vapour in the atmosphere plays a vital role in the life and activities of man. In selecting sites for sanatoria water vapour is one of the important factors invariably considered. Recent investigations have shown that there is an intimate relation between the incidence of respiratory diseases and water-vapour content of the air. In selecting sites for the storage of food grains and other commodities, for the storage of explosives, and for the establishment of industries like rubber, cotton, films, etc., water vapour in the atmosphere is a major factor which is taken into account. In the design of almost all important electrical equipment water-vapour content plays a significant part. Whether electrical or mechanical all equipment nearly breaks down when frost forms out of the water vapour present in the air trapped in it.

On this important constituent of the lower levels of the atmosphere there does not seem to have been made so far any detailed study for the Indian region. An attempt in this direction is made in this paper.

## DATA

The actual amount of water vapour present in the air is generally expressed in grams per cubic metre of air. This is not measured in India and therefore it is computed from the formula

$$\frac{(390.06)e}{t + 459.4} \text{ grams/cubic metre}$$

where  $e$  is vapour pressure in millibars and  $t$  is dry bulb temperature in °F. The normals of dry bulb temperature and vapour pressure for a number of stations are readily available in the publication *Climatological Tables of Observatories in India*. These refer to observations taken at a height of about 4 feet above ground. The data appearing in this publication are restricted to two principal synoptic hours—0800 and 1700 hours I.S.T. To get a comprehensive idea about the diurnal variation of water vapour, at least 6-hourly observations of dry bulb temperature and vapour pressure may be required. In the absence of these, the available data for 0800 and 1700 I.S.T. have been made use of to compute the normal amount of water vapour for these two hours for all the stations appearing in the above-mentioned publication.

## SEASONAL VARIATIONS

For the country in general water vapour in the air is a minimum in winter when conti-

ental air prevails over most parts of the country. In the hot weather season water vapour shows a general increase. Moreover its distribution in certain regions significantly differs from that during the winter season. In the monsoon season water vapour is maximum all over the country. After the withdrawal of the monsoon, the water vapour rapidly decreases. To understand the seasonal characteristics of water-vapour content in the air, the isolines of water vapour for the typical months of the four seasons are presented for 1700 I.S.T. (1130 G.M.T.).

In the winter and monsoon seasons there is practically no difference in the amount of water vapour at 0800 and 1700 I.S.T. The differences between these two hours in the other seasons are significant in certain regions; these are pointed out during the course of the discussion.

*Winter Season (December to February).*—In this season the lowest amount of water vapour is observed over Kashmir. Its higher elevation and the prevailing continental air seem to contribute to the dryness. At lower heights in the Kashmir valleys water vapour is about 4 gm./m.<sup>3</sup> Towards north where the general terrain increases in altitude, water vapour decreases to about 2 gm./m.<sup>3</sup>

Elsewhere in the country water vapour generally increases with decreasing latitude. This suggests that the continental air picks up moisture on its way from the higher to the lower latitudes. This is a feature observed even along the coastal regions. Maximum amount of water vapour 18 gm./m.<sup>3</sup> occurs in the southernmost coast south of 12° N.

Within a narrow belt of about 100 km. wide all along the coast except in the Madras State, water vapour rapidly increases towards the sea. The increase is about 6 to 8 gm. in the west coast and 4 to 6 gm. elsewhere within the 100 km. belt. Probably this is due to diffusion of water vapour from the lower levels of the oceanic atmosphere rich in water vapour.

In the Madras State also there is a definite increase of water vapour towards the Bay of Bengal but it is less marked and extends over a wider area covering the entire State. The increase of water vapour in this region is only of the order of 3 gm. per 100 km. towards the sea. This can be understood from the fact that in this region the seasonal winds are from the north-east coming across the Bay of Bengal and they bring moisture and rain far inland. The







for the hour 1700 I.S.T. At 0800 I.S.T. water vapour is practically the same as at 1700 I.S.T. except in Rajasthan and its adjoining areas where at 0800 I.S.T. water vapour is about 2 to 3 gm. more than that at 1700 I.S.T.

From Fig. 5 it can be seen that water vapour is a minimum, about 6 to 8 gm./m.<sup>3</sup>, in the elevated regions of Kashmir. In the plains the driest region with water vapour nearly 9 gm./m.<sup>3</sup> extends from Kashmir to the interior of Cutch-Kathiawar and from west Rajasthan to west Madhya Pradesh. To the south of Indore this dry region extends close to Sholapur in Maharashtra.

Towards Assam and coastal regions water vapour increases from this dry region. The increase is remarkably large within a narrow belt of about 100 km. from the coastal boundary. Close to the coast there are three distinct regions where the water vapour is a maximum, about 20 gm./m.<sup>3</sup>. One is at the south-west coast

stations except those in Kashmir where the general terrain itself is hilly. This is because the water-vapour content of the air at hill stations is normally far less than that at the low-level stations in the neighbourhood. Moreover, the diurnal variations of water vapour at hill stations, so far as can be seen from the 0800 and 1700 I.S.T. observations, seem to exhibit peculiar features which to a large extent may be depending upon their orography. To understand these, a more detailed study is required. For the present, therefore, in Table I are given for ready reference the normals of monthly and annual amounts of water vapour at selected popular hill stations.

From Table I it can be seen that maximum water vapour is observed at all the stations in the monsoon season and a minimum in winter season. Almost throughout the year there is a general tendency for water vapour in the afternoons (1700 I.S.T.) to be more than that in the

TABLE I  
Mean monthly and annual amounts of water vapour (grams per cubic metre of air) at selected hill stations

Station		Height above sea level (metres)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Pachmarhi	..	1075	I 7.4	7.1	7.0	7.4	9.7	15.1	16.8	16.3	15.8	16.3	8.6	7.6	11.8
			II 8.1	7.4	6.0	6.3	8.1	14.9	17.4	17.1	16.1	10.8	8.8	7.6	10.7
Mercara	..	1152	I 11.5	11.6	12.2	14.4	15.2	15.2	14.8	14.5	14.5	14.4	13.0	11.7	13.6
			II 11.0	11.2	12.0	15.3	16.8	15.8	15.5	15.6	15.5	14.1	13.3	11.2	13.9
Alm	..	1195	I 4.4	4.7	5.6	6.2	8.5	14.1	16.2	15.4	13.8	8.4	6.2	4.9	9.0
			II 5.1	5.9	5.4	5.9	9.9	15.2	17.0	15.9	14.8	8.2	5.9	5.5	9.6
Kalimpong	..	1209	I 7.6	8.1	8.8	10.8	14.3	17.0	17.7	17.5	16.7	13.2	10.0	8.2	12.5
			II 7.5	8.1	8.4	10.8	15.1	17.4	16.3	17.8	16.9	13.4	9.6	8.3	12.5
Mahabaleswar	..	1382	I 7.0	6.2	6.2	7.4	10.1	15.0	15.1	14.6	14.3	11.9	9.0	7.0	10.3
			II 8.8	8.3	9.7	12.7	14.6	16.0	15.1	14.9	15.2	12.6	9.4	8.6	12.2
Shillong	..	1500	I 6.6	6.8	6.9	8.5	12.3	14.5	15.3	15.1	14.3	11.9	9.1	7.0	10.7
			II 7.8	8.9	7.6	9.4	13.6	15.5	15.5	15.6	15.1	13.5	10.6	8.9	11.8
Mussoorie	..	2042	I 3.8	4.6	4.6	5.5	7.3	10.7	14.2	14.0	12.1	7.1	4.4	3.8	7.7
			II 4.8	5.8	6.1	6.0	8.4	12.5	15.1	15.1	13.0	8.6	5.9	4.9	8.9
Simla	..	2202	I 3.1	3.3	3.5	4.5	6.1	9.5	12.7	12.7	11.0	5.3	3.2	2.6	6.4
			II 3.8	4.7	4.3	4.3	6.5	11.1	14.1	14.0	11.1	6.6	4.1	3.9	7.4
Ootacamund	..	2249	I 5.7	6.1	6.3	7.9	9.3	10.0	10.1	9.9	9.9	9.5	8.8	6.8	8.4
			II 8.0	7.8	7.5	9.8	11.1	10.8	10.6	10.8	10.8	10.4	9.8	8.9	9.7
Mukteswar	..	2311	I 3.3	3.6	4.1	4.5	6.5	10.0	12.7	12.6	10.8	6.7	3.9	3.0	6.8
			II 4.0	4.9	4.5	4.6	8.3	11.5	13.9	13.7	11.8	8.1	5.1	4.1	7.9
Kodaikanal	..	2343	I 5.9	5.9	5.9	8.1	8.9	9.3	9.5	9.5	9.5	9.6	9.0	6.9	8.2
			II 8.5	9.1	8.9	10.3	11.2	10.7	11.5	10.0	11.1	10.5	11.0	8.9	10.1

Note.—I—at 0800 hrs. I.S.T. II—at 1700 hrs. I.S.T.

of Kathiawar. Another one extends from about latitude 20° N. near Goa to latitude 11° N. in the east coast. The third region is situated between Kakinada and Chandbali. These three regions hardly extend beyond 30 km. inland.

#### WATER VAPOUR AT HILL STATIONS

In the preceding discussion consideration was not given to the water vapour conditions at hill

forenoons (0800 I.S.T.). This is just contrary to what is generally observed at the plain stations. Normally one should expect a decrease of water vapour with increase in height. Some of the stations given in Table I, however, show higher water-vapour content in the atmosphere compared to those situated at a lower altitude. This is an important aspect to be borne in mind while choosing hill stations in India.

## LETTERS TO THE EDITOR

ULTRASONIC ABSORPTION IN  
AQUEOUS SOLUTIONS OF CADMIUM  
HALIDES

EXTENSIVE measurements on absorption of ultrasonic waves in aqueous solutions have been reported<sup>1-4</sup> at a fixed frequency. Markham, Beyer and Lindsay<sup>5</sup> classified them into groups and drawn certain conclusions from such data. Measurements by Wilson and Leonard<sup>6</sup> and Carstensen<sup>7</sup> on the frequency dependence of absorption coefficient yielded relaxation frequencies in the case of aqueous solutions of some electrolytes. In the present investigation study of ultrasonic absorption in aqueous solutions of the three electrolytes cadmium chloride, cadmium bromide and cadmium iodide has been taken up. These salts are known for their anomalous behaviour in regard to the variation of velocity with concentration, and they are also known to form complexes in solution.

The absorption in aqueous solutions is measured by using a modified form of the pulse technique of Pellam and Galt.<sup>8</sup> In this the transmitter is a pulse-modulated oscillator which supplies energy to the transmitting quartz crystal. The receiver is a similar type of quartz crystal of the same frequency. The output from the receiving crystal is amplified and detected by means of a receiver and the output pulse is displayed on an oscillograph. The distance between the transmitting and receiving crystals can be varied and is read by means of the scale on a travelling microscope base on which the transmitting and receiving crystals are mounted. By means of an attenuator introduced into the circuit, which is graduated to read decibels, the length of the liquid column through which the receiving crystal has to be moved in order to introduce attenuation of 1 db. and hence the absorption coefficient of the liquid under study can be determined.

In the present investigation two pairs of crystals with fundamental frequencies of 1.8 Mc./sec. and 3 Mc./sec. are used and measurements of absorption in the frequency range of 3 Mc./sec. to 22 Mc./sec. are taken by exciting these crystals at their odd harmonics. The crystal holders are thinly waxed to avoid short-circuiting of the crystal. The accuracy of the measurements is  $\pm 5\%$ .

The aqueous solutions of the salts are prepared by dissolving weighed quantities of the electrolyte in known amount of water. Absorption coefficients for each electrolyte at different concentrations have been measured. The measurements are repeated 2 or 3 times to ensure reliability of the measurements. The absorption coefficient for pure distilled water at 25° C. is measured in the frequency range of 16 Mc./sec. to 24 Mc./sec., and the value is found to be constant,  $20 \times 10^{-17}$  nepers. sec.<sup>2</sup>/cm. Values of  $a/f$  and  $a/f^2$  have been calculated at different concentrations for the electrolytes and these are plotted against frequency as shown in Figs. 1 to 3. The temperature of the aqueous solutions is 25° C. with a fluctuation of  $\pm 0.2^\circ$  C.

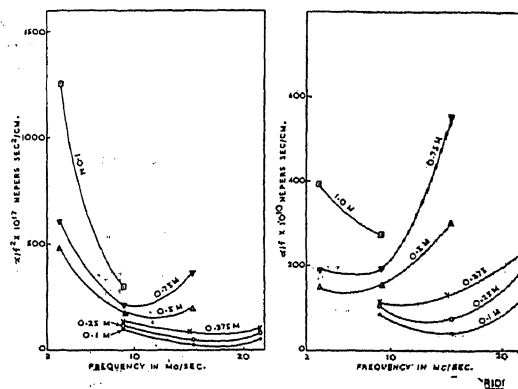


FIG. 1. Absorption in aqueous solutions of cadmium chloride.

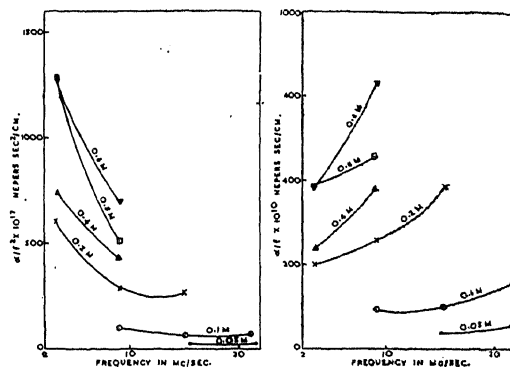


FIG. 2. Absorption in aqueous solutions of cadmium bromide.

From a close study of the curves it can be qualitatively inferred that the cadmium halides

possess two relaxation frequencies, one in the lower frequency range and another in the higher frequency range. However, exact quantitative relations for relaxation frequencies could not be established for want of data relating to the temperature variation of absorption at different frequencies, which could not be measured with the present equipment.

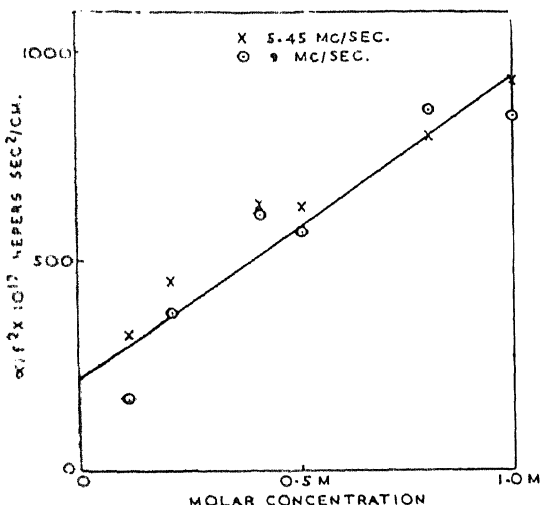


FIG. 3. Absorption in aqueous solution of cadmium iodide.

My thanks are due to Prof. B. Ramachandra Rao for his guidance and to the Council of Scientific and Industrial Research, New Delhi, for the award of a Senior Research Fellowship.

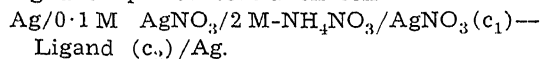
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## THE STABILITY OF COMPLEXES OF SILVER WITH THIUBASES

MORGAN AND BURSTALL<sup>1</sup> prepared a number of complexes of silver with thiourea and ethylene thiourea and measured electrical conductivities of some of them in aqueous solution. From these measurements they concluded that in aqueous solution these complexes play the role of compound radicals. They also observed a low solubility of these complexes in solution which indicated a considerable degree of association in solution. Fyfe<sup>2</sup> made an electrometric study of silver thiourea complex with a view to determining its formation constant. In the present investigation the authors have extended this study to silver complexes of ethylene thiourea and phenylene thiourea.

The e.m.f. measurements were carried out with a Precision Pye Potentiometer at 28° C. using a simple concentration cell



The solutions of silver nitrate and the ligands were prepared in dioxane-water mixture in the ratio 80 : 20. This was done to have a uniform basis for comparison of formation constants of Ag with different ligands. The choice was based on the solubility of phenylene thiourea which is very sparingly soluble in water but dissolves in 80 : 20 dioxane mixture.

The activity coefficient values were taken from MacInnes<sup>3</sup> *et al.* and it was assumed that the activity coefficients of the silver complex were the same as for silver nitrate. In calculating the formation constants of the thiourea and ethylene thiourea complexes the molar ratio of the ligand to silver was taken as 3 : 1 as it was found that when equimolar solutions of thiourea or ethylene thiourea and silver nitrate are mixed a precipitate is formed which dissolves when the two are present in the ratio 3 : 1. In the case of the phenylene-thiourea complex it was found that 3 : 1 molar ratio gave the best agreement between the formation constant values obtained with different concentrations of the ligand.

The log K values are presented in Table I in which  $K = (\text{AgL}_3)/(\text{Ag}^+)(\text{L})^3$  where L = ligand.

TABLE I

Ligand	..	..	log K
Thiourea	..	..	13.6
Ethylene thiourea	..	..	11.5
Phenylene thiourea	..	..	9.5

These are the mean of five values of log K for each ligand calculated from e.m.f. values

obtained with five different concentrations of the ligand.

The log K values, which are a measure of the stability of the silver complexes with the thio-bases, show that the stability decreases in the order thiourea > ethylene thiourea > phenylene thiourea. This indicates that steric factors influence the stability of these complexes, the stability decreasing with an increase in the size of the ligand. In all these complexes the linking of the thiobase molecules with silver appears to be through the sulphur atom which is indicated by comparatively higher values of stability constant in comparison with that of the silver-ammonia complex in which the linking is through the nitrogen atom. Fyfe<sup>4</sup> has shown with the help of overlap calculations that the higher stability of the metal-sulphur linkage is due to the low electron affinity of sulphur.

In the case of silver-thiourea complex Fyfe<sup>2</sup> has suggested that the silver atom forms a trigonal planar grouping with the three sulphur atoms with a  $sp^2$  silver hybrid. With ethylene- and phenylene-thiourea ligands, however, a trigonal pyramidal grouping appears to be more plausible because of steric considerations. This may perhaps explain the lower stability of their complexes with silver as compared to the thiourea complex since on wave mechanical considerations<sup>5</sup> the bond strength in the trigonal pyramidal grouping is lower than that in the trigonal planar grouping.

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#### TETRAMETHYL AMMONIUM TETRACHLORO IRON (III) COMPLEX

MANY hexa-co-ordinated complexes of trivalent iron are known<sup>1</sup> both of spin-free and spin-paired types, e.g.,  $[\text{FeF}_6]^{-3}$  and  $[\text{Fe}(\text{CN})_6]^{-3}$ , the former making use of  $4s\ 4p^3\ 4d_{\gamma}^2$  bonding orbitals and the latter  $3d_{\gamma}^2\ 4s\ 4p^3$ . To prepare a tetrahedral compound, a more readily pola-

risable ligand which makes a sexicovalent complex relatively less stable than a quadri-covalent one and a symmetrical non-bonding shell which brings in the least perturbation to the preferred stereochemistry are the necessary prerequisites.<sup>2</sup> The ferric ion has a  $d^5$  configuration and hence presents a symmetric half-filled non-bonding shell in case of spin-free complexes whilst the ferrous ion has an unsymmetric  $d^6$  configuration and hence a regular tetrahedral arrangement should be less probable than an octahedral one. It is of interest therefore to study the chloro complexes of ferrous and ferric ions. Even though  $[\text{FeCl}_4]^{-1}$  ion is known<sup>2</sup> earlier, the compound tetramethyl ammonium tetrachloro iron (III),  $(\text{CH}_3)_4\text{N}[\text{FeCl}_4]$ , does not seem to have been studied and reported in detail.

Tetramethyl ammonium chloride (0.11 g.) and ferric chloride (0.16 g.) were dissolved separately in minimum amounts of absolute alcohol. When these solutions were mixed and well shaken, a yellow crystalline compound was formed. Filtered through a glass-sintered funnel, washed with absolute alcohol followed by petroleum ether. Dried the compound in vacuo (Found: Fe—20.9%, Cl—51.4%,  $\text{C}_4\text{H}_{12}\text{NFeCl}_4$  requires Fe—20.5%, Cl—52.2%). The compound was readily soluble in water in which medium the conductance goes on changing with time with change in colour of the solution indicating decomposition. It does not melt up to 250° C. In solid form, the compound is paramagnetic indicating five unpaired electrons ( $\mu_{\text{eff.}} = 5.98\text{ B.M.}$ ). It is thus clearly a spin-free tetrahedral complex of iron (III) using  $4s\ 4p^3$  bonding orbitals. The ferrous complex is under investigation and will be reported in due course. Divalent manganese ion is isoelectronic with trivalent iron and a similar tetrahedral manganese (II) complex was reported<sup>3</sup> earlier.

Thanks are due to Jnan Vijnan Parishad, Utkal University, for a grant.

Department of Chemistry, K. C. DASH.  
Regional Engineering D. V. RAMANA RAO.  
College,  
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In thin section the black scheelite has numerous inclusions of epidote and an opaque mineral along the cleavages, sometimes well oriented. For a correct idea of the opaque mineral, a study of the polished section is also made. Minute but distinct flakes of molybdenite are seen with typical hexagonal habit, showing bright whitish colour (of galena), weak bireflection and very strong anisotropism. Some larger crystals of the mineral are also observed at the contact of scheelite with quartz. Very few samples have even prominent plates of molybdenite, distinguishable megascopically.

When studied chemically (Fonseca, 1961) one sample gave a value of 3.90% of  $\text{MoO}_3$  and 76.90% of  $\text{WO}_3$ . Spectrochemical data of the same are as follows: Majors—W, Ca, Mo; Minors—Mg, Si; Traces—Mn, Fe.

The final verification was however made by the X-ray powder method in which characteristic lines of both scheelite and molybdenite are noted, together with unidentifiable reflections of calc-silicates. The data are given in Table I, comparing them with those of Berry and Thompson (1962).

TABLE I  
X-ray data

Black Scheelite, Brazil (Present study)		Berry and Thompson			
		Scheelite		Molybdenite	
<i>d</i>	I	<i>d</i>	I	<i>d</i>	I
6.20	M-St	..	..	6.28	10
3.06	VSt	3.09	10	..	..
2.34	M	..	..	2.28	9
1.921	St	1.929	9	..	..
1.830	W-M	..	..	1.824	6
1.602	St	1.595	9	..	..

V—very; St—Strong; M—medium; W—weak.

The scheelite deposit here is known to be of contact metasomatic origin (Johnston, Jr. and Vasconcellos, 1944) succeeded by hydrothermal activity (Bhaskara Rao, 1960). Thus the search for a scheelite-powellite variation (Bhaskara Rao, 1961) continues, though there are no doubts that black scheelite no longer be included in that investigation.

The assistance of Dr. V. K. Nayak in mineralogical study is hereby acknowledged.

Escola de Geologia de Pernambuco,  
Dept. de Mineralogia e Petrografia,  
Universidade do Recife,  
Recife, Brazil, March 3, 1964.

A. BHASKARA RAO.

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## LOWER PALAEOZOIC FOSSILS FROM THE KASHMIR HIMALAYA

THOUGH much stratigraphical and palaeontological work has been carried out in other Himalayan areas like Sikkim, Kumaon, Spiti, etc., no systematic attempt appears to have been made to explore the Lower Palaeozoic fossiliferous horizon of the Kashmir region. Detailed work was therefore organized last year by the senior author.

The earliest reference to the geology of the Kashmir Himalaya appears to be by Lydekker (1889). He declared the whole of his Panjal System (Cambrian-Silurian) to be unfossiliferous with the exception of some obscure organic impressions from one locality. The first reference to fossil finds in the area under review is by Middlemiss (1910). This fauna was described by Cowper Reed (1912) who assigned an Upper Llandovery or Wenlock age to the beds. Since then no fossils appear to have been described from the Lower Palaeozoic of the Kashmir Himalaya.

The present note deals with a collection made by the junior author during the field season 1963, and includes many forms in addition to those already described.

Lithologically the rock consists of a 100 ft. thick band of sandy, occasionally calcareous, shales full of casts and impressions of *Orthis*, etc., usually coated with yellowish limonite. These shales are medium to fine-grained and have been hardened at places by a small proportion of calcareous matter.

The present contribution records the first find of graptolites besides corals, gasteropods, crinoids and bryozoa from the Lower Palaeozoic of the Kashmir Himalaya.



In addition to the forms already described the fauna from this locality includes various species which have been provisionally identified as follows:

GRAPTOLITES: *Didymograptus* sp. and *Dicellograptus* sp.

CORALS: *Favosites spitiensis* Reed., *Cyathophyllum* sp. and *Palæocyclus porpita* (Linn.).

GASTROPODS: *Hormotoma salteri* Ulrich., *Tentaculites* sp., *Platystoma* Conard and *Hyolithes* sp.

CRINOIDS: *Stephanocrinus angulatus* Conard.

BRYOZOA: *Monticulipora* sp. and *Fenestrelina* sp.

TRILOBITES: *Calymene nivalis* Salter, *Phacops elegans* (Sars and Boeck)?, *Phacops* sp., *Dalmanites* sp., *Flexicalymene* sp., *Encrinurus sexocostatus* Salter (?), *Encrinurus* (Cromus) *beaumonti* Barrande, *Encrinurus* cf. *punctatus*, *Asaphiscus* sp. (?) and *Dikelocephalus* sp.

BARCHIPODS: *Atrypa reticularis* Linnaeus, *Bilobites bilobus* Linnaeus, *Lingula* sp., *Siphonotreta verrucosa* Vern, *Rafinesquina* sp., *Sowerbyella* sp., *Spirifer* sp. (several forms) and *Orthis* sp. (several forms in addition to those already described).

The collection also includes cephalopods, but precise identification cannot be made at this stage on account of their poor state of preservation.

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Panjab University,  
Chandigarh, March 5, 1964.

M. R. SAHNI.  
V. J. GUPTA.

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### THE MUZZAFFARPUR METEORITE— A RARE NICKEL-RICH ATAXITE\*

ON April 11, 1964, at 5 p.m., two pieces of an iron meteorite fell at Baharampur 26° 08' : 85° 32' (226 A) and Man Bishunpur 26° 07' : 85° 31' 15" (226 B)—two villages 1.6 km. apart, about 13 km. east of Muzaffarpur in the Muzaffarpur district, Bihar. According to the local people, roaring thundrous sounds were heard at the time of the fall. The meteorites have been acquired from Shri S. N. Gupta, Inspector of Explosives, Government of India, and have been registered in the collections of the Geological Survey of India.

On-the-spot investigations were carried out by Shri Srivastava. The meteorite is the fourth recorded fall of an iron meteorite in Indian territory, besides one find (Kodaikanal, found 1898); the others are Nedagolla (fell 1870), Samelia (fell 1921) and Bahjoi (fell 1934). The two pieces weigh 1,092 grammes (226 A) and 153 grammes (226 B). Since this is one of the few meteorites recovered within a few days of the fall, it is of considerable interest regarding investigations for short-lived isotopes. The small piece has been loaned to the Smithsonian Institution of Washington, U.S.A., for such studies. The larger piece is being currently investigated by the Geological Survey of India. The specimens show interesting morphological characteristics, including a complex history of fall as indicated by the orientation of the several systems of striae on the fusion crust.

Study of etched, polished surfaces reveals extremely interesting features. The meteorite consists almost entirely of fine, parallel sets of taenite bands, often arranged in an octahedral fashion. Kamacite is interstitial, and minor, forming locally fine, discontinuous bands. The meteorite is also characterised by relatively thick, sharply demarcated bands of taenite, surrounded by kamacite, and in places with a core of bronze-yellow schreibersite—the phosphide of iron, nickel and cobalt. Schreibersite is here recorded for the first time in Indian meteorites.

The chemical analysis carried out by N. R. Sen Gupta is given in Table I.

TABLE I

Constituents			Per cent.
Si	..	..	0.31
Fe	..	..	86.30
Ni	..	..	12.03
Co	..	..	0.76
P	..	..	0.56
S	..	..	Trace

The chemical analysis as well as the molecular ratio Fe/(Ni + Co) 6.7 conform to a nickel-rich ataxite.

The Muzaffarpur meteorite is unique among Indian iron meteorites; the others are octahedrites (Samelia, Bahjoi and Kodaikanal) and one nickel-poor ataxite (Nedagolla). This is apparently the 37th fall of nickel-rich ataxites recorded in the world (Mason, 1962, p. 142).

Geological Survey of India,  
Calcutta,  
June 12, 1964.

M. V. N. MURTHY.  
S. N. P. SRIVASTAVA.  
A. DUBE.  
N. R. SEN GUPTA.

\* Published with the kind permission of the Director-General, Geological Survey of India, Calcutta.

### HISTOLOGICAL STUDY OF THE GUSTORECEPTORS OF *MYSTUS VITTATUS*

AMONG the fishes gustatory or taste organs have been reported in the regions of barbels and lips. Walter (1928) termed these organs as gustoreceptors. The present note briefly deals with the cutaneous sense-organs (gustoreceptors) of *Mystus vittatus*.

These organs are found in abundance over the lips in the form of taste buds, but their behaviour on both the lips is different. It has been observed that the taste buds are more concentrated on those surfaces which are always in direct contact with the food.

**Structure of a single taste bud.**—The single taste bud is a spheroidal or flask-shaped structure surrounded by the epithelial cells. The two types of cells that form the taste buds are as follows:

(i) Gustatory or neuroepithelial cells which are elongated cells that taper towards both ends; the ovoid nuclei occupy the broadest parts of the cells, while the outer part of each cell ends in a thread-like strip of protoplasm projecting into a pit-like depression in the outer layer of the stratified epithelium (Fig. 1).

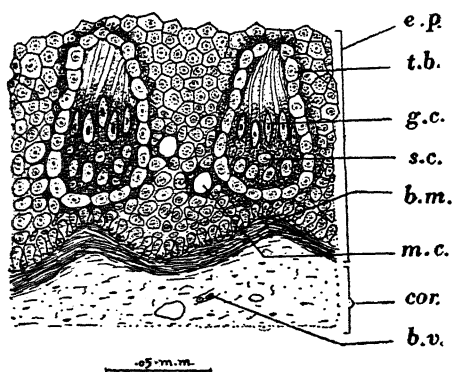


FIG. 1. Part of the section of dorsal lip showing taste buds (b.v., blood vessel; cor., corium; e.p., epidermis; g.c., gustatory cells; m.c., mucous cell; s.c., sustentacular cells; t.b., taste bud.)

(ii) Sustentacular or supporting cells are deeper in position than the gustatory cells. They vary in shape according to the position they occupy and are distinguished by their more or less rounded shape, such rounded cells cover the taste buds at the sides and work as a supporting sheath. At the base of the bud, they become narrow and long and lie in between the gustatory cells, which they support. On their sides, they form a sort of envelope and resemble the surrounding epithelial cells.

The gustatory cells get stained so deeply that the bulbous part of the taste buds appears as a dark mass of nuclei. The supporting and the gustatory cells described here correspond respectively to the nutritive and the sensory cells of Picket (1909) and other authors.

May (1925), while working on *Amiura*, observed cells which display an intermediate stage between typical gustatory and sustentacular cells. However, no such intermediate stages have been observed in *Mystus vittatus*.

Taste buds are totally absent on the barbel of the fish. This shows that the barbels in this fish are tactile and not gustatory in nature.

Sato (1937 b) summarised his observations by classifying the barbels on the basis of their histology; the salient features for grouping being the presence or absence of taste buds.

I am highly indebted to Dr. V. P. Agrawal and Dr. O. P. Khandelwal for their help and guidance.

Zoological Laboratories, V. K. RAJBANSHI,  
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### CYCLIC VENTILATION MOVEMENT IN THE COMMON COCKROACH *PERIPLANETA AMERICANA*

THE respiratory movements of insects aiding in hyperventilation, have been known for a long time.<sup>1,2</sup> Miller<sup>3</sup> has shown that in the desert locust *Schistocerca gregaria*, the normal abdominal ventilation movement is interrupted by pauses; but this has not been reported in other insects.

The common cockroach, *Periplaneta americana*, at rest and kept at 29° C. shows a consistent pattern of abdominal movements occurring in cycles lasting about 9 to 12 minutes particularly noticeable in adult males (Fig. 1). In an hour the ventilation movement is interrupted by six pauses, each burst of activity being followed by a complete inactive period. 20 to 30 ventilation strokes characterise each burst of ventilating activity which lasts for 3 to 4 minutes. In the first few strokes, the amplitude slowly increases and after reaching a maximum there is little change in it. Each burst of ventilation is followed by a pause where movement of abdomen is not observed. The respiratory pause

# SUSCEPTIBILITY OF THE COCKCHAFER *HOLOTRICHIA* SP., TO *BACILLUS THURINGIENSIS* BERLINER

The cockchafer grub, *Holotrichia* sp. (Coleoptera: Melolonthidae) is an important pest of arabica coffee, *Coffea arabica* Linn., in South India. The grub feeds on the root system, primarily on the feeder roots. With high population in the soil in July-October, rearing and establishing healthy plants present difficulties. Today, grub control is achieved through the application of Aldrin or Dieldrin to the soil. But, in view of the economic and other limitations involved in their large-scale use, alternative methods that could substitute or supplement the existing

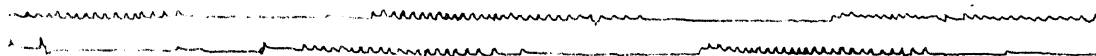


FIG. 1. Kymograph tracing of the ventilation movement of *Periplaneta americana*  
Temp.: 29° C. Scale: 1 cm. = 1 minute.

lasts for 6 to 7 minutes, after which the ventilation-activity starts again. In a normal resting animal also, the same phenomenon was observed and apparently this seems to represent the normal behaviour of the animal.

The ventilation stroke starts with the longitudinal telescopic movements of the abdominal segments as a result the whole abdomen is lowered. This expiration phase is active and is followed by the inspiration phase brought about by the elasticity of the integuments.

The significance of the cyclic abdominal movement is not yet clearly understood. In many larval and adult insects, carbon dioxide is retained within the tracheal trunks and released during brief periods of bursts of respiratory movements and this synchronises with the spiracular rhythm.<sup>1</sup> It is possible, the cyclic ventilation movement in cockroach may have a similar function.

I wish to thank Prof. S. Krishnaswamy for his helpful suggestions.

Dept. of Zoology, AL. PAULPANDIAN.  
University of Madras,  
Madurai Centre,  
Madurai-2, S. India, March 23, 1964.

ones have to be evolved. This note records the preliminary observations made in the above context with the microbial insecticide, *Bacillus thuringiensis* Berliner, in the laboratory.

*B. thuringiensis* has been tested on several animals.<sup>8,9</sup> Its pathogenicity is mainly attributed to the solubility of the protein crystals, normally formed during sporulation, in the alkaline gut juice of the hosts.<sup>1-2,6-7,10</sup> The observation that the pH in the mid-gut of the cockchafer grub is greater than 9.0 thus indicated that this species may also be susceptible to the pathogen.

The following viable spore preparations of the bacillus were used: (1) Thuricide wettable powder 30 × 10<sup>9</sup> spores and (2) Thuricide dust 3 × 10<sup>9</sup> spores per gram (Stauffer Chemical Co., Inc., California)—the spore counts cited are those given by the manufacturer. For comparison, Aldrin was used at 0.05% and 0.1% active ingredient of a 30% emulsifiable concentrate.

A mixture of jungle soil and cattle manure (3:1) was apportioned into lots of 1,200 grams each (dry weight). The moisture content of the lots ranged from 36% to 38% and the pH from 6 to 7. The treatments were replicated thrice and each of the three lots of the mixture was separately treated. In the case of the wettable powder, specified weight of the formulation was diluted in 20 to 25 ml. water, blender agitated and was then incorporated into the lot. The spore counts of the dust treatments were equated to those of the wettable powder. The treated lots were filled into standard polythene

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nursery bags. Untreated checks were also maintained. One S. 795 arabica coffee seedling, 8 months' old, was planted in each bag to serve as food for the grubs. Second instar grubs, collected from an infested coffee field were used, there being 5 grubs per replication. In order to diagnose and eliminate unhealthy grubs—since a few cases of infection by the fungus, *Metarrhizium anisoplaea* (Metch.) Sorokin, were detected in some coffee areas—they were observed for a few weeks before being subjected to treatment. Observations on susceptibility were conducted on 7, 15 and 21 days after treatment.

The results showed that dust (D and E) was comparable to Aldrin (G and H) in inducing a high degree of susceptibility by the seventh day. As opposed to this, the maximum degree of susceptibility observed in the case of the wettable powder (A) was considerably low and a lower rate of treatment (B) was still less effective. The latter, however, induced increased susceptibility by the twenty-first day while the former, though remaining static, maintained a higher level. The lowest rate of treatment (C and F) did not evidence any effect in the three periods of observation. No mortality was observed in check (Table I).

TABLE I

*Susceptibility of the cockchafer, Holotrichia sp., to Bacillus thuringiensis and Aldrin*

Treatment	Rate	Per cent. susceptibility (accumulative)*		
		7 days	15 days	21 days
Thuricide wettable powder ( $30 \times 10^0$ )	A 1.0 gm.	26.7	26.7	26.7
	B 0.5 "	6.7	6.7	13.3
	C 0.05 "	0	0	0
Thuricide dust ( $3 \times 10^0$ )	D 10.0 "	100	..	..
	E 5.0 "	100	..	..
	F 0.5 "	0	0	0
Aldrin (30 E.C.)	G 0.1% a.i.	100	..	..
	H 0.05% "	95.0	100	..
Control	I	0	0	0

\* Include dead and moribund grubs; a.i., Active ingredient.

Assuming that the viable spore counts of the dust and wettable powder treatments were the same (see para above), the dissimilarity observed in susceptibility at the higher rates of application—A and B on the one hand and D and E on the other—might be attributed to the differences in the crystalline inclusions.<sup>3,12</sup> The non-susceptibility at the lowest rate of application of dust (F) would suggest insufficient dosage.

Coffee seedlings in D, E, G and H, in contrast to others, did not evidence any damage to the root system. Visible pathogenic effects on the grubs were sluggishness, oral discharges, gradual discolouration of the body turning to black on death and general flaccidity. Some of the affected grubs exhibited a disproportionately swollen anal segment.

While *B. popilliae* Dutky is recognized as an effective pathogen to control several soil pests,<sup>4,5,11</sup> the present studies suggest that *B. thuringiensis* can also be pathogenic. Detailed studies on its comparative effectiveness and persistence in soil in the coffee nursery and field are programmed.

The authors thank Dr. N. G. Chokkanna, Director of Research, for the encouragement, their colleagues in the Division for the help and M/s. Mysore Insecticides Co., Madras, for supplying the spore materials.

Division of Entomology, P. S. SEKHAR.  
Central Coffee Res. Inst., G. H. VENKATARAMIAH.  
Chickmagalur District, Mysore State,  
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#### VARIABILITY IN C.T.I. 425-4 (*GOSSYPIMUM HIRSUTUM* LINN.)

THE attack of jassid (*Empoasca devastans* Dist.) and leaf roller (*Sylepta derogata* Fabr.) are the major problems encountered in the successful cultivation of American cottons in Uttar Pradesh. Ten strains of C.T.I. types were introduced from Madhya Pradesh during 1960, which were derived from the cross of CO<sub>2</sub> × *Tomentosum* × Indore 2. All these strains were grown at Chief Cotton Research Station, Uttar Pradesh, Bulandshahr, in unreplicated rows of ten plants each of the strain during 1960. Only two plants of C.T.I. 425-4 survived. In 1961, both deeply and broad-lobed plants were observed. The broad-lobed plants were selfed. In 1962, seven

plants could survive, out of which two narrow-lobed plants appeared. One narrow-lobed plant was selfed and ten seeds were sown therefrom during 1963. Five plants having the following characters survived:

- Broad-lobed plant .. One
- Medium-lobed plant (Bulandshahr  $\alpha$ ) .. One
- Narrow-lobed plants (Bulandshahr  $\beta$ ) Three

The morphological and the economical characters were recorded which have been reproduced below:

**Broad-lobed plant.**—It has the erect habit with dwarf growth and possesses 2-3 ascending vegetative branches, slightly overtopping the main stem. It develops the first sympodial branch after 11 to 12 nodes. The leaves are broad, less cut into 3 to 4 divergent lobes. Lobes broadly triangular with acuminate tips. Bolls are big in size with tapering at the end of the boll. Leaves are green and sparsely hairy on both the surfaces. The ginning percentage of this plant ranges between 37.5 and 37.8 with the staple length of 25.1 mm. The fibre weight is 205 Milli-tex units with the spinning value of 39 counts.

**Bulandshahr  $\alpha$  (Medium-lobed plants).**—The plants are dwarf and bushy in nature with 2-3 short spreading vegetative branches shorter than the main stem. Stem tips and leaves are densely hairy. Leaves are medium size,  $\frac{1}{2}$  cut into 3-4 divergent lobes. The bolls are big and long. The first sympodial branch appears after 7-8 nodes at the base of the main stem. The ginning value varied from 35.9% to 36%, fibre length 23.1 mm., fibre weight 190 Milli-tex units and spinning value 34 counts.

**Bulandshahr  $\beta$  (Narrow-lobed plants).**—The plant is dwarf, bushy with 2-3 short spreading vegetative branches and bears the first sympodial branch after 7-8 nodes at the base of stem. The leaves are light green which are generally divided into three lobes. They spread in the manner of a claw of a bird, remaining connected at the base only thus confirming to the "pedate" type. This type of leaf makes the plant resistant to leaf roller. The leaves are covered with a thick coating of soft hairs on both the surfaces. The ginning percentage of this plant ranged between 35.3 and 35.5 with the staple length of 22.1 mm. and 188 Milli-tex units fibre weight. It can spin upto 31 counts.

All the three types, i.e., broad-lobed, Bulandshahr  $\alpha$  and Bulandshahr  $\beta$  plants are resistant to jassids. Bulandshahr  $\alpha$  and Bulandshahr  $\beta$  types are also resistant to leaf roller. These can be used for mechanical picking and for increasing the plant population per unit area.

Chief Cotton Res. Station,  
Uttar Pradesh, Bulandshahr,  
February 10, 1964.

HARI G. SINGH.  
S. K. GOVIL.  
R. N. RAM.

# CULTIVATION OF NOSEMA MESNILI PAILLOT (MICROSPORIDIA) IN VITRO

CONSIDERABLE interest is being shown in the cultivation of different protozoans, specially the parasites of the vertebrates, *in vitro*.<sup>1-3</sup> With many the schizogonic cycles within the vertebrate hosts, and in some the sporogonic cycles within the invertebrate hosts too have been studied<sup>4-5</sup> *in vitro*. In comparison to these the only investigation on the *in vitro* cultivation of protozoans parasitizing insects is that of Trager,<sup>6</sup> who obtained partial development of amoebuli of *Nosema bombycis* Naegeli to planonts in a silkworm tissue culture. In the present paper the results of an investigation on the cultivation of a microsporidian *Nosema mesnili* Paillot in the tissue culture of *Pieris brassicae* L. *in vitro* are reported.

The medium used for the *in vitro* cultivation of tissues was modified Trager's D<sub>4</sub>.<sup>7</sup> The experimental insects (4th stage larvæ of *P. brassicae*) were fed with cabbage leaves smeared with a *N. mesnili* spore suspension. After 24 hours of feeding, the larvæ were dissected and the tissues, gut and the fat body, were put in the roller tubes containing the medium modified Trager's D<sub>4</sub>. The roller tubes were set to rotate at 12 r.p.h. The cultures were maintained at 26° C. At the time of putting the tissues in the culture medium, mostly sporozoites and trophozoites were found. After 7 days of cultivation, the tissues were found to be full of matured spores (Fig. 1). Almost all the tissues were completely damaged. The size

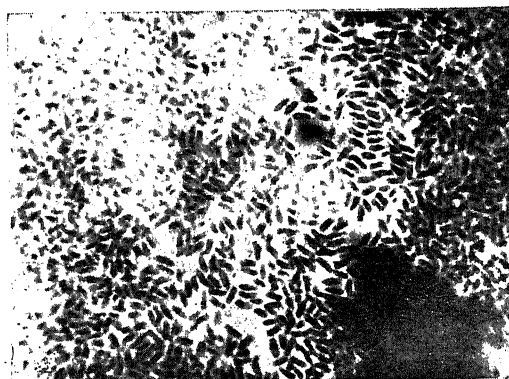


FIG. 1. Condition of an intestinal tissue explant from *P. brassicae*, cultured *in vitro* for 7 days following *in vivo* infection with *N. mesnili* spores showing (below left) part of the tissue and a mass of matured spores (stain Heidenhain's hematoxylin,  $\times 600$ ).

and form of the spores were similar to those grown *in vivo*.

The above observation is particularly important for further studies on the development of such pathogens as also for the laboratory preparation of large quantities of such living pathogens for the biological control of harmful insects.

Thanks are due to Dr. S. Krishnaswami, Director of Research, Central Sericultural Research Station, Berhampore, for his valuable suggestions in the preparation of the paper.

Institute of Biology, K. SEN GUPTA.\*  
Czechoslovak Acad. Sci.,  
Prague-6, Czechoslovakia,  
January 28, 1964.

\* Present address: Central Sericultural Research Station, Berhampore, W. Bengal, India.

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#### EFFECT OF POLYPHENOLIC EXTRACTS OF CASSIA FISTULA AND ACACIA CATECHU ON THE SPORE GERMINATION OF COLLETOTRICHUM FALCATUM WENT.

A SURVEY of about a dozen tannin-bearing plants to determine the fungitoxicity of their tan extracts has revealed that *Acacia catechu* Willd., *Cassia fistula* Linn. and *Cassia tora* Linn. are active and inhibit spore germination of *Piricularia oryzae* Cav. and *Colletotrichum falcatum* Went.<sup>1</sup> A detailed examination of the different polyphenolic fractions of *Acacia arabica* Willd. towards the fungitoxicity against *Piricularia oryzae* Cav. has shown that low molecular weight polyphenols and perhaps only to a limited degree, the polymerised condensed tannins are mainly responsible for fungitoxicity.<sup>2</sup> Such a detailed examination is now done with a view to determine the fungitoxic activity of the various polyphenolic fractions from *Cassia fistula* Linn. and *Acacia catechu* Willd. towards *Colletotrichum falcatum* Went. The results are reported in this note.

The following fractions were isolated from the solid tan extracts of *C. fistula* and *A. catechu* and tested in the present study: chloroform soluble extract (Fraction A), Ethyl acetate

soluble extract (Fraction B), Acetone soluble extract (Fraction C), amorphous polyphenolic extract (Fraction D), gummy fraction from ethyl acetate (Fraction E), tannin fraction precipitated with lead acetate (Fraction F), and phlobatannins precipitated with saturated sodium chloride solution (Fraction H). The efficacy of the fractions were compared against the respective solid tan extracts extracted with water. The method of preparing the crude extract and the different polyphenolic fractions is the same as reported earlier (*loc. cit.*).

The effect at various concentrations of the different fractions was tested by the slide germination method as in earlier tests. The data given in Table I form the averages of three replicates.

TABLE I  
On percentage germination of conidia of  
*Colletotrichum falcatum* Went.

Fraction	Species	Percentage germination of conidia at different concentrations of the test materials				
		1.0%	0.1%	0.01%	0.001%	Check
Water extract	1	Nil	4.6	25.7	52.8	86.0
	2	"	7.2	24.0	63.7	75.9
Fraction A	1	4.8	13.5	38.5	66.7	90.9
	2	2.7	38.1	62.5	66.6	72.1
" B	1	Nil	Nil	3.0	62.0	78.5
	2	"	"	22.4	61.8	74.8
" C	1	1.4	5.5	27.5	57.2	76.6
	2	Nil	8.6	20.0	53.9	75.5
" D	1	"	1.9	33.1	60.8	74.6
	2	"	4.3	43.0	65.0	75.7
" E	1	1.5	4.4	58.6	59.7	77.7
	2	Nil	15.5	46.6	60.0	79.8
" F	1	"	0.8	7.4	39.6	60.0
	2	"	2.5	11.4	57.1	71.5
" H	1	"	Nil	40.0	65.6	83.2
	2	"	1.0	5.5	78.2	76.4

1 = *Cassia fistula* Linn. bark. 2 = *Acacia catechu* Willd. heartwood.

It appears that low molecular weight polyphenols extracted by ethyl acetate (Fraction B) and to a limited degree, polymerised condensed tannins precipitated with lead acetate and sodium chloride (Fractions F and H) are mainly responsible for the fungitoxicity, as indicated by the respective germination figures for the conidia of *C. falcatum* Went.

Regional Research Lab.,  
Jorhat, Assam,  
March 24, 1964.

D. N. BORDOLOI.  
J. N. BARUAH.  
D. GANGULY.  
P. R. RAO.

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**LEPTOSPHAERULINA TRIFOLII**  
(ROST.) PETR., A NEW RECORD FOR  
INDIA

In the course of investigation of fungi causing leaf-spot diseases in Bhopal the authors encountered a leaf-spot disease of *Cassia obtusifolia*, *C. tora*, and *C. absus* at Bhadbhada Road side, Bhopal, on 23rd August 1963.

The spots which start as dark brown dots finally enlarge and exhibit a central greyish-white region bounded by a raised dark brown margin. Black spherical ascocarps become prominently perceptible in the central region of the spots. More than two spots often coalesce together forming large irregular patches. Isolations from the infected portions consistently yielded *Leptosphaerulina trifolii*, which is being presented here as a new record for India along with its three new host records.

**Colony characteristics in culture.**—The fungus isolated and cultured on Asthana and Hawker's medium 'A', forms a colony consisting of dark appressed, submerged, spreading mycelium. The surface of the colony which is slow-growing becomes covered with an almost solid crust of large black, often compound ascocarps. No ascospores were formed in ascocarps when the cultures were kept in dark.

pale brown, measuring 77–206  $\mu$  (means 100–150  $\mu$ ) in diameter, immersed ascostromata erumpent at the apex and opening by a broad pore in a short neck of darker brown cells, completely filled with 5–15 large saccate asci. Asci (Fig. 1, 1 A and C) thick-walled, bitunicate, arising individually and successively within the centrum parenchyma, remaining more or less separated by this parenchymatous tissue at maturity and measuring 55–115  $\times$  27–48  $\mu$  (average 90  $\times$  40  $\mu$ ). The inner wall of the ascus is especially thick at the apex and partially penetrated by a pore into which the protoplast extends. Beneath its dome-shaped apex, the pore extends laterally into a flat ring resembling the brim of a hat. Ascospores (Fig. 1, I and M) eight in each ascus, irregularly clustered, mostly muriform rarely phragmosporous, 3–5  $\times$  0–4 septate, measuring 20–45  $\times$  10–17  $\mu$  (average 33  $\times$  14  $\mu$ ), dark brown at maturity and surrounded by a thin gelatinous sheath, typically hyaline but often becoming brown and tearing into fragments at maturity.

The voucher specimen and culture has been deposited at C.M.I., Kew, London, as Nos. 102493 and 102492 respectively. The authors express their grateful thanks to Prof. O. N. Handoo for facilities and encouragement. Thanks are also due to Dr. J. C. F. Hopkins, Director, and Dr. Booth of C.M.I., Kew, for identifying the fungus.

Pathology Section, H. N. SATYA.  
Department of Botany, V. K. RAJALAKSHMY.  
M.V. Mahavidyalaya,  
Bhopal, March 2, 1964.

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**A NEW SPECIES OF PHYLLOSTICTA**  
**ON THE LEAVES OF**  
**MURRAYA EXOTICA L.**

In the course of their mycological collections, the authors encountered a leaf-spot on *Murraya exotica* L. which on examination was found to be caused by a species of *Phyllosticta*. Detailed morphological studies of the isolate revealed it to be a distinct species of the genus. As it could not be placed in any of them it is presented here as a new species.

The disease starts in the form of very small, circular, light buff-coloured regions which may be marked out on both the surfaces of the leaf. Gradually these regions spread out in all the directions and cover a considerable area of the

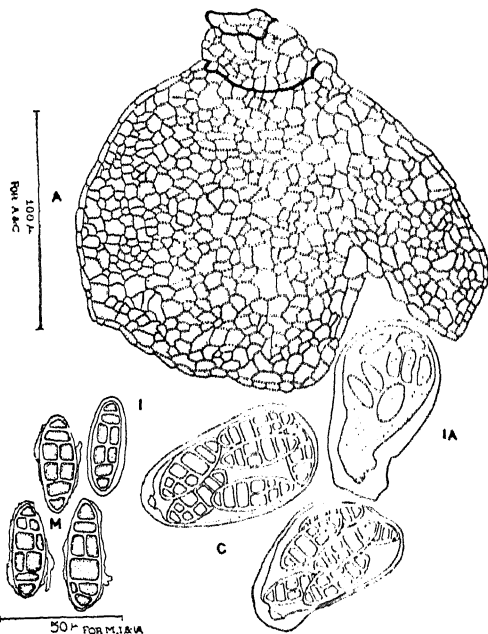


FIG. 1

**Morphological characters.**—Ascocarps (Fig. 1, A) small, spherical, parenchymatous, membranous,

leaf. In later stages the colour of the spots varies from pale ochraceous-buff to pale ochraceous-salmon. As the spots increase in dimensions, small black bodies (the pycnidia) make their appearance. In older spots the pycnidia are visible throughout the infected region. The spots may assume various shapes and are not delimited by midrib, vein or margin.

*Phyllosticta murrayae* sp. n.

Pycnidia pallide brunnea, membranacea, globosa vel subglobosa, 86.6–348.6  $\mu$  diam, mediet. 234.3  $\mu$ , conidiophora simplicia, hyalina, minuta, conidia hyalina, unicellularia, ovalia vel cylindrica, 2.8–4.2  $\times$  1.0–1.4  $\mu$ , mediet. 3.4  $\times$  1.2  $\mu$ . Mycelium pallide vel fusce brunneum, 4.3–4.7  $\mu$  crassum.

In foliis viventibus *Murrayae exoticae* L. ad Alfred Park, Allahabad, in India, septembri 1963, leg. S.C. Typus positus in herbario instituti mycologici. Commonw. ad Kew, No. 102520.

*Phyllosticta murrayae* sp. n.

Pycnidia light brown, membranous, globose to subglobose, 86.6  $\mu$ –348.6  $\mu$  in diameter, average 234.3  $\mu$  (Fig. 1), conidiophore simple, small,

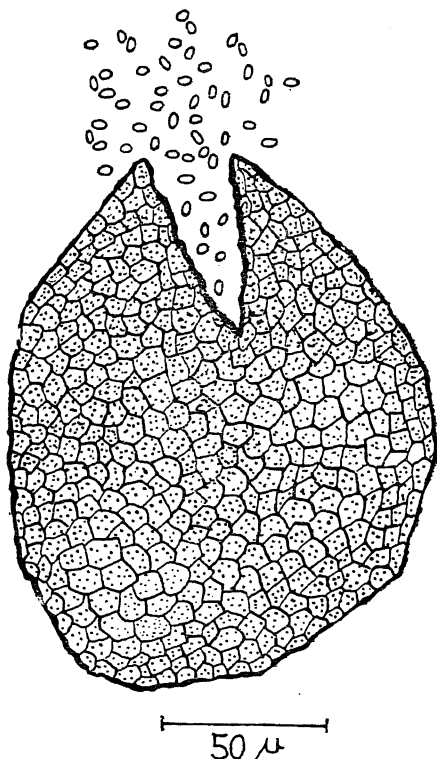


FIG. 1. *Phyllosticta murrayae*—Pycnidium and conidia.

hyaline, conidia hyaline, single-celled, oval to cylindrical, 2.8–4.2  $\times$  1.0–1.4  $\mu$ , average 3.4  $\times$  1.2  $\mu$ , mycelium light brown to dark brown, 4.3–4.7  $\mu$  in thickness.

On living leaves of *Murraya exotica* L., Alfred Park, Allahabad, India, September, 1963, leg. S.C.

The type specimen has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew, No. 102520.

Our grateful thanks are due to Rev. Father Prof. H. Santapau, Chief Botanist, Botanical Survey of India, for Latin diagnosis of the species and to Dr. J. C. F. Hopkins, Director and Mr. Sutton, Assistant Mycologist of C.M.I., Kew, England, for their help in identification of the species.

Botany Department, SUDHIR CHANDRA.  
University of Allahabad, R. N. TANDON.  
Allahabad, January 17, 1964.

#### A NOTE ON *MAURANDIA ERUBESCENS* (G. DON) A. GRAY FROM INDIAN HILL STATIONS

*Maurandia erubescens* (G. Don) A. Gray, a Mexican species of the family Scrophulariaceae, was introduced into India as an ornamental vine from England during the early part of the nineteenth century. According to Sweet,<sup>1</sup> A. B. Lambert procured seeds out of his dried specimens that were collected in Mexico by the Spanish botanists Sessé and Mocino, and liberally distributed them to various nurseries in England. The plant was cultivated in the Botanic Garden at Calcutta about the year 1840 and reported to have produced flowers freely during the cold season. The species is now found quite naturalized in Indian Hill Stations at Simla, Nilgiris, Shillong, Khasi Hills and Darjeeling (1980 m.). It has also run wild at Coonoor Ghat, Nilgiris District (1830 m.). This note is probably the first record of this species occurring as an escape from cultivation. At Shillong and Darjeeling, it grows vigorously covering trellises, pergolas and houses. The species is thus a great acquisition to our collections of exotic vines. Besides, *Maurandia barclayana* Lindl., *M. semperflorens* Ort., *M. antirrhini-flora* H. and B. ex Willd., and *M. scandens* A. Gray, are also cultivated in India (see Voigt,<sup>2</sup> Woodrow,<sup>3</sup> Cooke,<sup>4</sup> Santapau<sup>5</sup>). However, the plants passing in Indian gardens as *M. scandens* need to be worked out botanically. A careful study reveals that most of the material cultivated as *M. scandens* is *M. erubescens* A. Gray. The



correct name, synonymy and salient features of this species are given below :

*Maurandia erubescens* (G. Don) A. Gray in *Proc. Amer. Acad.*, 7, 377, 1868; Wettstein in *Engl. and Prantl., Nat. Pfam*, IV, 3 b, 61, t. 28, 1891; Bailey, *Stand. Cycl. Hort.*, 4, 2012, 1916; Britton, *Fl. Bermuda*, 347, 1918; Bailey and Bailey, *Hort. Sec.*, 468, 1941; Bailey, *Man. Cult. Pl. rev. ed.*, 895, 1949; Chittenden and Syngce, *Dict. Gard.* (ed. 2) 3, 1264, 1956. *Lophospermum erubescens* G. Don, *Gen. Syst.*, 4, 533, 1837. *L. scandens* Sweet, *Brit. Fl. Gard. Ser. II*, 1, t. 68, 1831, non D. Don (1827). Fig. 1.

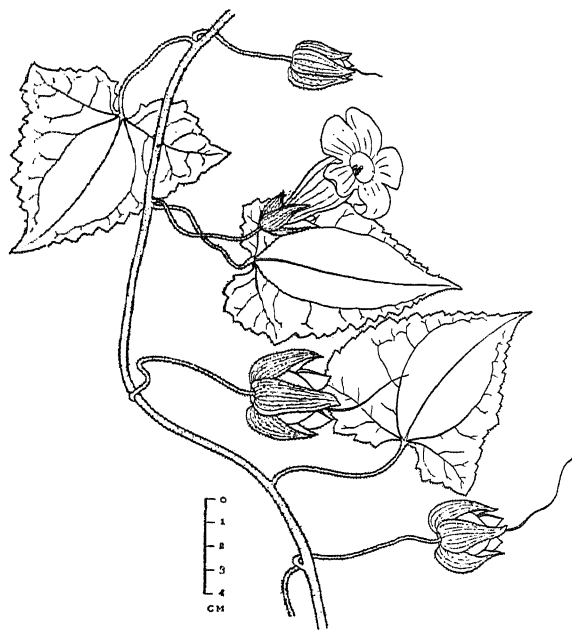


FIG. 1. *Maurandia erubescens* (G. Don) A. Gray: Flowering and fruiting twig.

A magnificent, glandular-hairy climber. Stems hard and woody at the base, much branched. Leaves variable in form, flat, lower ones 8-15 cm. long and the same in breadth in the broadest part, cordate at the base, triangular, shortly acuminate, dilated considerably a little above the base and terminated in a sharp point on both sides, unequally toothed, strongly 3-nerved from the base, each of the side nerves producing two other horizontal ones a little above the base and are again branched; upper leaves alternate, smaller, more hastate towards the base, sharply toothed; petioles nearly cylindrical, thickly clothed with soft glandular hairs, coiling.

Flowers axillary, solitary, ebracteate, rosy-red, about 7.5 cm. long; pedicels long, twining. Calyx deeply 5-cleft, clothed with slender hairs; sepals oblong-ovate, acute, erect, leafy, about 3 cm. long. Corolla showy, irregular, tubular at the base, tube somewhat ventricose; limb 5-lobed, lobes broad and rounded or notched. Stamens 4, fertile and one sterile, inserted at the base of the tube, included, didynamous; anthers 2-lobed; staminode very short. Ovules numerous. Capsules short. Seeds with a lacerated wing.

Native of Mexico. Its climbing stems, copiously adorned with leaves and large blossoms, render it a very desirable object. The plant climbs by a remarkable arrangement; the petioles and pedicels folding themselves over any available support and holding on by pressing like a letter-clip. It is cultivated in Indian Hill Stations as an ornamental vine on porches, trellises, pergolas and locally seems established at Coonoor Ghat, Nilgiris District, South India (Herb. CAL). The plant flowers and fruits freely in winter in a cool greenhouse and can be propagated by seeds or cuttings of young shoots under glass (see Bailey,<sup>6</sup> Chittenden and Syngce<sup>7</sup>).

Common name : Red Maurandya.

Flowering and Fruiting : October-February.

Central National Herb., J. K. MAHESHWARI.

Indian Botanic Garden,

Howrah, February 28, 1964.

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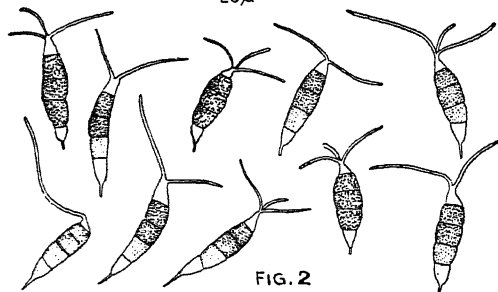
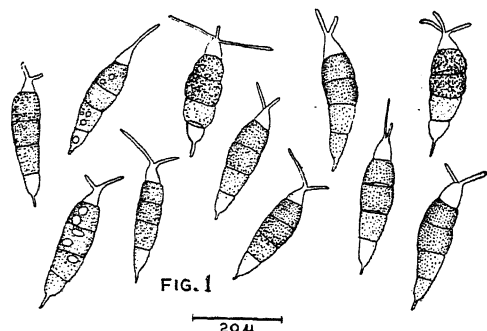
## TWO SPECIES OF *PESTALOTIOPSIS* FROM SOIL

ALTHOUGH the genus, *Pestalotiopsis* Steyaert, has been mentioned to be present in the soil, specific descriptions have not been given so far.<sup>1</sup> While studying the seasonal variation and distribution of fungi in some soils of Hyderabad (Andhra Pradesh), the author has isolated two species of *Pestalotiopsis*, which are new records for the

soil. Of the two *P. glandicola* forms a new addition to the fungi of India. Therefore, they are described below.

*Pestalotiopsis glandicola* (Cast.) Stey., in *Bull. Jard. bot. Brux.*, 19, 330, 1949; Steyaert, R. L., *Trans. Brit. mycol. Soc.*, 36, 86, 1953.

Colonies of the fungus growing rapidly on potato sucrose agar at room temperature, producing white cottony aerial mycelium; acervuli appearing quickly after four days; acervuli black, 1-2 mm. in diameter, in the older colonies many acervuli fuse to form drops of slimy black fluid over the vegetative mycelium. Reverse of the colony greyish-brown, or black at certain parts. Conidia fusiform, 4-septate, guttulate, constricted at the septa, measuring  $24.0-28.0 \times 6.2-7.8-9.0 \mu$ , three middle cells brownish-black, upper two darker and broader,  $14.0-18.6 \mu$  in length; apical cell hyaline, conical, bearing a crest of usually two or three short setulas, sometimes with only one setula; setulas slender, uniform, unbranched, variable in length,  $2.0-7.0-15.0 \mu$ ; basal cell sub-hyaline to slightly coloured, conoid, tapering to a pedicel,  $2.0-5.5 \mu$  long.



FIGS. 1-2. Fig. 1. *Pestalotiopsis glandicola* conidia. Fig. 2. *P. mangiferæ* conidia.

Isolated from the soil of a deciduous forest, maize field (Narsapur, Medak District) and an uncultivated land, Hyderabad.

The present isolate is interesting in possessing short setulas. However, some conidia bear appreciably longer setulas. Prof. R. L. Steyaert feels that these are abnormal conidia of *P. glandicola* and hence, is described as such.

*Pestalotiopsis mangiferæ* (P. Henn.) Stey., in *Bull. Jard. bot. Brux.*, 19, 320, 1949; Steyaert, R. L., *Trans. Brit. mycol. Soc.*, 36, 83, 1953.

Colonies of the fungus spreading with white aerial mycelium, producing the acervuli rather slowly on potato sucrose agar; acervuli appearing after ten days, warty, black, globose to sub-globose, 1-2 mm. in diameter; reverse of the colony colourless. Conidia fusiform, 4-septate, with faint constrictions at septa,  $19.0-26.0 \times 4.6-6.2-7.0 \mu$ , three middle cells concolorous, or sometimes two upper cells darker and broader, golden-brown,  $10.0-14.0 \mu$  in length; apical cell short, conical, hyaline, with a crest of 2 to 3 divergent setulas or with only one setula; setulas long, slender, tapering, unbranched,  $6.0-23.0 \mu$  long; basal cell sub-hyaline to pale golden-brown, conoid tapering to a pedicel,  $3.0-7.3 \mu$  long.

Isolated from a garden and an uncultivated soil, Hyderabad.

The culture of *P. glandicola* is deposited in C.M.I., Kew, and *P. mangiferæ* will be deposited in I.A.R.I., New Delhi.

The author is grateful to Prof. R. L. Steyaert, Bruxelles, Belgium, and Prof. J. C. F. Hopkins, Director, C.M.I., Kew, for their help in the identification. He is also thankful to Dr. M. A. Salam and Prof. M. R. Suxena, Botany Department, Osmania University, Hyderabad, for kind encouragement.

Botany Department, P. RAMA RAO.  
Osmania University,  
Hyderabad-7, India, March 19, 1964.

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## REVIEWS

**Real Gases (Vol. I of Engineering Physics Series of Monographs).** By Ali Bulent Cambel, Donald P. Duclos and Thomas P. Anderson. (Academic Press, New York and London.), 1963 Pp. 166. Price \$6.50.

Flight within the lower reaches of the atmosphere imposes an environment which, by and large, allows the aerodynamicist to treat air, the fluid medium, through which his vehicle flies, as a continuum. Accounting for viscosity, compressibility and thermal conductivity phenomena at ordinary temperatures and pressures the aeronautical engineer, until the recent past, was able to design reasonably efficient aerial vehicles for continuous flight within the atmosphere up to moderate supersonic Mach Numbers and altitudes of the order of 10 miles or so. With the high altitudes and velocities reached by ballistic missiles and artificial satellites and the high temperatures encountered in rocket nozzles and by space-craft re-entering the Earth's atmosphere the idealized concepts of perfect gas theory are no longer adequate. Inter-molecular forces, electronic excitation, reaction and ionization, dissociation and re-combination are phenomena which the engineer has to take account of in his designs for such applications. The theoretical foundations for the study of such Real Gas phenomenon were of course laid by physicists quite some time ago. Today developments in aero-space technology makes it increasingly necessary to use these aspects of Physics in engineering applications. This book is intended as an introduction to the physics of Real Gas effects. The authors are active in research in the aero-space fields. They adopt a balanced approach in their presentation neither over simplifying nor dwelling inordinately on the complexities. In general, derivations of formulas is avoided, presumably because they can be found elsewhere in the literature. The relevant equations are given and their realm of applicability discussed. It would have been perhaps helpful to the uninitiated if important references were cited in this context. The first three chapters introduce the reader to the concept of a Real Gas outlining qualitatively the behaviour and giving the conservation equations governing the processes. Chapter 3 discusses the thermal and caloric equations of State and quotes results of classical Maxwell-Boltzmann statistics regarding the partition

function, law of mass action and Saha's equation for equilibrium ionization reactions. Approximations such as Lighthill's ideal dissociating gas are also briefly touched upon. Chapter 4 discusses the Debye-Hückel Theory of ionized gases and summarises its validity and limitations in the light of recent work. Chapter 5 is a brief chapter devoted to a summary of high pressure effects which have significance in Hypersonic wind tunnel calibrations. Chapters 6 and 7 deal with dissociation and ionization phenomenon. These areas of chemical kinetics are of importance to the aero-thermo dynamicist when dealing with Hypersonic Flight and Gas dynamic phenomenon occurring in propulsive engines. The simple kinetic theory treatment of gas-phase reactions is reviewed and a brief account given of the experimental techniques used for study of heterogeneous reactions. The last Chapter (7) contains a sketchy description of ionization and re-combination processes.

In retrospect this short monograph provides a, on the whole, useful introduction to real gas phenomenon.  
S. DHAWAN.

**Informational Macromolecules.** Editors: H. J. Vogel, V. Bryson and J. O. Lampen. (Academic Press), 1963. Pp. xix + 542. Price \$16.50.

The book under review is the proceedings of a Symposium held at the Institute of Microbiology of Rutgers from September 5 to 7, 1962. It deals mainly with the recent progress made in the fields of Protein Synthesis and Genetic Code. The book is divided into seven parts, two parts each on polynucleotides, the genetic code and protein synthesis and the remaining one on protein structure. The emphasis is throughout laid on the biosynthesis and functioning of molecules which carry information for the synthesis of protein. The book starts with the opening address by Professor Severo Ochoa on the mechanism of protein synthesis. There is also a later paper by Professor Ochoa on the genetic code. The two parts dealing with synthesis and properties of polynucleotides contain nine papers on the syntheses of DNA, RNA, and mixed polymers and on the secondary and tertiary structure of ribonucleic acids. The only paper in Part V dealing with protein structure is a masterly paper by Christian B. Anfinsen on the assembly process in protein synthesis

and its relation to the molecular structure. The two parts dealing with protein synthesis contain eleven papers on the synthesis of proteins using artificial and natural templates. The parts on the genetic code, a current topic of very great interest, contain eight papers, by leading scientists in the field. These deal with the important aspects like nucleotide sequence in code words, code word assignments and the universality of the code.

Each part is followed by a record of the lively discussions which followed. The volume contains very good author and subject indices. At a time when the advances in this borderland fields of biochemistry, genetics and biophysics are making rapid progress, a book of this type will certainly serve the excellent purpose of providing those interested in the field with the latest information in a single volume.

G. N. R.

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**Advances in Heterocyclic Chemistry (Vol. II).**

Edited by A. R. Katritzky. (Academic Press, New York), 1963. Pp. xiv + 458. Price \$14.00.

This is a worthy successor to Volume I, and if the present standard is maintained, the entire series will be most valuable to workers in heterocyclic chemistry as a source of information, answers to queries, and problems for investigation.

The first two chapters (A. R. Katritzky and J. M. Lagowski) are a continuation of two in Volume I covering prototropic tautomerism; they deal with the tautomerism of pyrroles and five-membered rings with two or more hetero atoms. E. Schmitz, who described the first authentic diaziridine in 1959, has written a fascinating account of three-membered rings with two hetero atoms: oxaziranes, diaziridines, and diazirines. No ring of this type had been constructed until 1950, but "their formation occurs surprisingly smoothly" and they "have become, in a very short time, classes of compounds with an extensive literature". Paulsen (1960) and Schmitz (1961) independently synthesized diazirines, the cyclic isomers of the diazoalkanes for which Angeli proposed the now accepted linear structure over fifty years ago; Schmitz and Ohme synthesized the parent diazirine, cyclic diazomethane, in 1961. Among the numerous interesting reactions discussed by Schmitz are the practicable syntheses of alkylhydrazines from 1-alkyl-diaziridines and N-alkyl-N'-acylhydrazines from 1-alkyl-2-acyl-diaziridines.

Arylation, alkylation, hydroxylation and halogenation of heteroaromatic compounds by free radical substitution are discussed by R. O. C. Norman and G. K. Radda. Treatment of pyridine with degassed Raney nickel is the method of choice for the preparation of 2, 2'-bipyridyl; the mechanism of the reaction, side reactions and other aspects are discussed by G. M. Badger and W. H. F. Sasse on the basis largely of their own important work. Progress in quinoxaline chemistry since about 1955 is reviewed by G. W. H. Cheeseman. In the chapter on the reactions of diazomethane with heterocyclic compounds (R. Gompper) a very useful section on reaction mechanisms precedes methylation and other reactions of diazomethane. G. F. Smith has surveyed the acid-catalyzed polymerization of pyrroles and indoles. Methods of preparation and properties of 1, 3-oxazine derivatives are described by Z. Eckstein and T. Urbanski; the latter in 1951 was the first to draw attention to their interesting reactivity and potential value as chemotherapeutic agents. The chapter on "The present state of selenazole chemistry" (E. Bulka) consisting of sections on "syntheses with (of?) selenazoles" and "reactivity of selenazoles" fills a gap in the literature; no other review has so far appeared. The parent compound, selenazole, is still unknown. The concluding chapter on "Recent developments in isoxazole chemistry (N. K. Kochetkov and S. D. Sokolov) is most interesting and stimulating, because of the unique chemical character of the isoxazoles and their biological activity; the powerful oral hypoglycaemic action of some simple isoxazoles has been disclosed in a recent patent.

K. V.

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**The Chemistry of Flavonoid Compounds.** Edited by T. A. Geissman. (Pergamon Press, London), 1962. Pp. viii + 666. Price £ 7-10 sh.

A review of the up-to-date knowledge of the *Chemistry of Flavonoid Compounds* was long overdue. This has now been accomplished very thoroughly, as different chapters, dealing with the occurrence, isolation, structure determination, spectral properties, interconversion, stereochemistry, biosynthesis, chemico-genetical studies and also the economics, have been written by several authorities in the field. The book is of particular importance to the researchers in the field because of many experimental details given in it.

D. K. BANERJEE.

**The Biosynthesis of Vitamins and Related Compounds.** By T. W. Goodwin. (Academic Press, London and New York), 1963. Pp. 366. Price 70 sh.

This new publication will provide those interested in vitamins and their role as coenzymes very valuable and useful material with critical evaluations at several places and show the remarkable progress achieved in research in vitamins. Excellent chapters on the state of research work till end of 1962 and in some cases till early 1963 have been compiled on the water-soluble vitamins: thiamine, riboflavin, nicotinic acid, folic acid, pantothenic acid, biotin, pyridoxin, vitamin B<sub>12</sub>, choline, inositol and ascorbic acid and the related compounds associated with each of the above vitamins. The important coenzymatic role of water-soluble vitamins is cited and discussed fairly exhaustively. Four very valuable chapters are also devoted to essential fatty acids and fat-soluble vitamins: A, D, E and K. The fact that vitamin research has made very rapid strides in the last few years with excellent team-work of scientists in different disciplines is very well brought out in this publication. Furthermore, emphasis is placed by citing publications on the merit and scope of new techniques, in particular, the use of labelled compounds in biosynthetic pathways in the field of enzyme and vitamin research. However, it must be mentioned that there are a few omissions, in particular, the relationship of thiamine to lipoic acid is conspicuous by its absence. This book will serve a most useful purpose to a post-graduate student in Biochemistry in the adequate scrutiny of literature as well as to research workers interested in the biochemistry of both the water-soluble and fat-soluble vitamins.

H. R. CAMA.

**South Indian Fruits and Their Culture** (Second Edition). By K. C. Naik. (P. Varadachary & Co., 8, Linghi Chetty Street, Madras-1), 1963. Pp. xvi + 335. Price Rs. 20-00.

The publication of this treatise on South Indian Fruits is the outcome of the author's long-standing experience extending over nearly three decades as Horticulturist on various fruit research stations situated in Punjab, Bihar and Madras, culminating in his intensive research on fruit trees on the Kodur Farm. The book provides information valuable not only to the Scientific Research Workers in this field, but, more important and useful, to the orchard

owner, giving details of field operations such as irrigation methods, application of manures and pest and disease control. The book is illustrated with 110 photographs and drawings and will be useful to orchard owners and students of fruit research.

Part I deals on all aspects of orchard cultivation and Part II deals in detail with all aspects of culture of individual fruits, as well as a miscellaneous array of fruits such as *Carambola*, *Inga dulce* and prickly pear.

M. J. NARASIMHAN.

#### Books Received

From: (Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y.):

*Microbiological Quality of Foods.* By L. W. Slanetz, C. O. Chichester, A. R. Gauffin and Z. J. Ordal, 1963. Pp. xxiii + 274. Price \$ 9.00.

*Advances in Oral Biology* (Vol. I). Edited by P. H. Staple, 1964. Pp. xiii + 350. Price \$ 14.00.

*Fluorine Chemistry* (Vol. 3) and (Vol. 5). By J. H. Simons, 1963 and 1964. Pp. xi + 240; xv + 505. Price \$ 10.00; \$ 16.50.

*Vitamins and Hormones—Advances in Research and Applications.* Edited by R. S. Harris, I. G. Wool and J. A. Loraine, 1963. Pp. x + 374. Price \$ 13.00.

*Ergodic Theory.* Edited by F. B. Wright, 1963. Pp. xii + 316. Price: \$ 8.00.

*Magnetism: A Treatise on Modern Theory and Materials* (Vol. 1). Edited by G. T. Rado and H. Suhl, 1963. Pp. xv + 688. Price \$ 19.00.

*Metabolic Inhibitors a Comprehensive Treatise.* (Vol. II). Edited by R. M. Hochster and J. H. Quastel, 1963. Pp. xviii + 753. Price \$ 29.00; Subn.: \$ 24.00.

*The Harvey Lectures* (Series 58), 1964. Pp. xiv + 331. Price \$ 9.50.

*Primary Processes in Photosynthesis.* By M. D. Kamen, 1963. Pp. xii + 183. Price \$ 5.50.

*Italian Physical Society—Proceedings of the International School of Physics "Enrico Fermi": Course 19—Cosmic Rays, Solar Particles and Space Research.* By G. Polvani, 1963. Pp. xii + 418. Price \$ 16.00; Course 21—

*Liquid Helium.* By G. Careri, 1963. Pp. xi + 442. Price \$ 16.00; Course 22—*Semiconductors.* By R. A. Smith, 1963. Pp. xi + 540. Price \$ 22.00.

*Non-Glycolytic Pathways of Metabolism of Glucose.* By S. Hollmann. (Translated and revised by Oscar Touster), 1964. Pp. ix + 276. Price \$ 12.00.

*Radiation, Radioactivity and Insects.* By R. D. O'Brien and L. S. Wolfe, 1964. Pp. xv + 211. Price Cloth \$ 5.95. Paper \$ 3.45.

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## SCIENCE NOTES AND NEWS

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### Award of Research Degree

Andhra University has awarded the Ph.D. Degree in Botany to Shri M. Umamaheswara Rao for his thesis entitled "An Ecological Study of Some Intertidal Algae of the Visakhapatnam Coast".

### Symposium on Palynology

A "Symposium on Palynology", which would provide a forum for Indian Palynologists to meet for the first time, has been tentatively fixed for 19-21 October, 1964, at the National Botanic Gardens, Lucknow. Those who are interested to participate can write to: Shri P. K. K. Nair, Secretary, Symposium on Palynology, National Botanic Gardens, Lucknow.

### Symposium on Oils and Fats—1964

The 20th Annual Convention of the Oil Technologists' Association of India will be held in Delhi from 26 to 29 December 1964. A Symposium on Oils and Fats is being organised on this occasion. The Soybean Council of America incorporated and the Vanaspati Manufacturers' Association of India have agreed to co-sponsor the Symposium.

The Symposium will consist of two Technical Sessions and a Group Discussion on subjects of economic importance to the development of oils and oil-based industries. Papers containing results of original investigations, plant studies and reviews on subjects falling within the broad scope of the Symposium are invited for discussion at the Symposium by 30 September 1964.

Further information can be had from the Convener, Symposium on Oils and Fats—1964, Ganesh Flour Mills Co., Ltd., Post Box 1025, Delhi-6.

### Raptakos Medical Research Board—Award of Fellowships

The Raptakos Medical Research Board will consider applications for the award of Fellowships of values Rs. 3,000 and Rs. 6,000 per year for research work on medical and allied subjects in recognized institutions situated in the Union of India.

Applications (in the prescribed form to be had from the Secretary) for grants for the year, commencing January 1, 1965, should reach the

Secretary and Treasurer, Raptakos Medical Research Board, Dr. Annie Besant Road, Worli, Bombay-18, before September 30, 1964.

### Lady Tata Memorial Trust Scholarships and Grants for the Year 1964-65

The Trustees of the Lady Tata Memorial Trust announced on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1964, the awards of scholarships and grants for the year 1964-65.

International Awards of varying amounts (totalling £ 7,190) for research in diseases of the blood with special reference to Leukæmias are made to: Dr. B. Pedersen (Denmark), Dr. K. M. Laurence (U.K.), Dr. J. de Maeyer (Belgium), Dr. A. Agostoni (Italy), Dr. G. Corneo (Italy), Dr. D. Quaglino (Italy), Dr. F. Squartini (Italy), Dr. G. Trindente (Italy).

Indian Scholarships of Rs. 250 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to: Mr. R. Chatterjee (Calcutta), Dr. R. C. Chawla (New Delhi), Miss Niloufer J. Chinoy (Baroda), Dr. Fredy J. Daniel (Kanpur), Miss N. Jayalakshmi (Madras), Mr. A. G. Palekar (Bombay), Dr. K. T. Shetty (Lucknow) and Miss V. C. Trivedi (Bombay).

### Automatic Amino-Acid Analyser

A new facility, an automatic amino-acid analyser, has now become available at the Indian Institute of Science, Bangalore.

The completion of its installation under direction of Kenneth R. Woods of Cornell University, U.S.A., was announced by Prof. P. S. Sarma of the Biochemistry Department of the Institute. This instrument, a gift of the Rockefeller Foundation, is capable of automatically determining which among the twenty different amino-acids that make up proteins are present in a sample and in exactly what amounts. It is an essential tool of investigations of protein structure and may also be applied to the analysis of blood and urine in the diagnosis of certain types of hereditary disorders. It can also be applied to studies of the protein quality of foods. Some foods, cereal grains in particular, though high in proteins, lack one or more of the essential amino-acids. When a diet of this type is con-

sumed, much of the protein may not be utilized. The analyser can be used to pinpoint dietary deficiencies of this sort and to provide information which can be utilized for enhancing the protein quality of foods by adding the limiting amino-acid or blending foods. It incorporates many improved features not yet available in commercial models.

#### Stellar Radio Source 3 C 147—the Most Distant Object in Space

The galaxy designated 3 C 295 was considered till recently to be the most distant object in space. This has now been superseded by the quasi-stellar radio source 3 C 147 which has been found to be 10 to 20% more distant than 3 C 295. This has been reported by Schmidt of the Mount Wilson and Palomar Observatory and Matthews of the Radio Observatory of the California Institute of Technology.

The distance estimates are based on the well-known fact that light received from distant objects is shifted toward the red end of the spectrum, indicating that the objects are receding as part of the general expansion of the universe. According to Schmidt the red-shift of the lines of ionized oxygen and ionized neon measured in spectrograms of 3 C 147 obtained with the 200-inch telescope was about 54.5% of their undisplaced wavelengths. This corresponds to an apparent recession velocity of 76,000 miles per second. The apparent recession velocity of 3 C 295 is 67,000 miles per second. This observation makes 3 C 147 the "most distant object in space" at present.—(*Scientific American*, May 1964.)

#### The Alaskan Earthquake of March 28, 1964

The following scientific details of the recent Alaskan earthquake are taken from an article by E. Tillotson in *Nature*: Preliminary determinations of the epicentre of the shock place this at 61.1° N., 147.8° W. The depth of focus is considered shallow and the Richter logarithmic magnitude between 8.2 and 8.6 makes this one of the world's greatest earthquakes. The epicentre is east of Anchorage, Alaska, and the origin time was 1964 March 28d 03h 36m 10s G.M.T. Aftershakes continued for several days. Eight shocks above magnitude 6 were experienced on the first day March 28, and there were many smaller ones. On March 30 at 02h 18m 05s G.M.T., from the Kodiak Island region came a shock of magnitude 6.7.

The Aleutian Islands arc from Komandorski Islands to Alaska, and Alaska itself must be con-

sidered a major seismic and volcanic zone of the earth. For example, in 1959 alone there were some 40 earthquakes felt and recorded in Alaska. Shocks greater than magnitude 6 and of shallow depth of focus near to the present epicentre also occurred in 1932 September 14, 1933 January 4, 1934 June 2 and August 2. Perhaps the greatest of the previous Alaskan earthquakes were on September 3 and 10, 1899, at Yakutat Bay both of magnitude about 8½.

In the Aleutian Islands arc shallow-focus seismicity follows the northern concave side of the Aleutian trench, being less intense near the Komandorski Islands. At the eastern end of the arc activity is higher near the Kenai Peninsula. This seismic activity is only exceeded by that of Mexico, Japan and the Solomon Islands. The shallow shocks in the interior of Alaska indicate an interior structure related to the Pacific coastal arc, in the same way as the Rocky Mountains are related to the Pacific coastal ranges farther south in America.—(*Nature*, 1964, 202, 336.)

#### Contact-Bend-Stretch Rolling

An innovation in the rolling of steel and other metals may make it possible to use lighter and cheaper equipment in the manufacture of metal strip. The new technique in which the strip is squeezed, bent and pulled simultaneously is called "contact-bend-stretch" (C-B-S) rolling. It was invented by L. F. Coffin of the General Electric Research Laboratory.

In conventional "contact-stretch" rolling a thick strip of metal is made thinner by pulling it between two heavy rollers. From a study of the effects of plastic strain on metals, Coffin found that less pressure and tension are required to reduce the thickness of the strip if plastic bending is added to the forces usually applied in a rolling mill. One form of C-B-S rolling involves five rollers around which the strip travels in four loops. The overall size and weight of such an arrangement is considerably less than that of the conventional rolling mill of similar capacity.

Strips up to 12 inches wide have been rolled by the new process. In one case the thickness of a strip of stainless steel was reduced from 0.09" to 0.012" in four passes and without annealing the metal between passes. To do the same job conventional rolling methods would require about a dozen passes and several intermediate annealings.—(*Scientific American*, May 1964.)

# Model 421 high-resolution SPECTROPHOTOMETER offers uninterrupted scan from 2.5 to 18 microns

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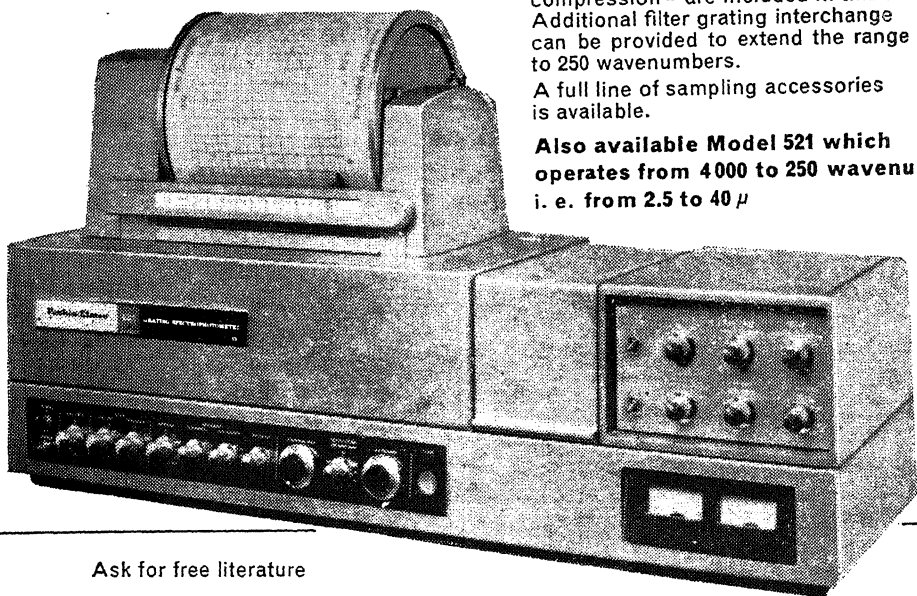
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7/77A Tilaknagar, Kanpur



## RAMAN-EFFECT SYMPOSIUM AT FREUDENSTADT : II

### 4. MEASUREMENTS OF INTENSITY IN RAMAN SPECTRA (Contd.)

*Measurements of the Absolute Intensity of Raman Lines of Gaseous  $\text{CCl}_4$*  by W. Holzer and H. Moser, of Munich : The measurements were carried out with a scattering tube of one meter length, a multireflexion system of 4 mirrors (enhancement factor 30), 4 low-pressure Hg lamps (total of 10 m. length of discharge tube) and a three-prism Steinheil spectrograph and photoelectrical registration.

According to Golden and Crawford the intensities were determined relative to 1-3 rotation line of  $\text{H}_2$ . Corrections were made for the spectral sensitivity and convergence angle.

#### Results

$$\nu_1 : a_{11}^2 = 4.6 \times 10^{-33} \text{N}_L \text{ cm}^4/\text{g} \pm 10\%$$

$$\nu_2 : g_i \gamma_{11}^2 = 5.6 \times 10^{-33} \text{N}_L \text{ cm}^4/\text{g} \pm 20\%$$

$$\nu_4 : g_i \gamma_{11}^2 = 9 \times 10^{-33} \text{N}_L \text{ cm}^4/\text{g} \pm 20\%$$

$$\nu_3 : g_i (45 a_{11}^2 + 13 \gamma_{11}^2) \approx 3.5 \times 10^{-31} \text{N}_L \text{ cm}^4/\text{g}$$

$a_{11}$  and  $\gamma_{11}^2$  are the trace and anisotropy of derivation of polarisability tensor,  $g_i$  the orientation grade of the oscillation.

There are similar measurements for the  $\nu_1$  and  $\nu_4$  lines, by Schrötter and Bernstein; the results agree well.

*Raman and Infra-red Intensities of Some Silicon and Tin Organic Compounds* by H. Kriegsmann, of Berlin-Adlershof : In a large number of compounds of type  $\text{R}_3\text{SiX}$ ,  $\text{R}_3\text{SnX}$ ,  $\text{RSiX}_3$  and  $\text{RSnX}_3$ , the Raman and infra-red intensities of the characteristic frequencies have been measured. It was established that the  $\text{CH}_3$ - and  $\text{SiC}$ -oscillations in silicon compounds show no characteristic intensities, while in the tin compounds, for these oscillation groups one can speak of characteristic intensities in almost all cases. The  $\text{SiH}$  valence frequencies were investigated in detail. In the compounds of class  $(n\text{-alkyl})_3\text{SiH}$  (sec-correspondingly iso-alkyl) $_3\text{SiH}$  and (Alkoxyl) $_3\text{SiH}$ , there occur, however, characteristic  $\text{SiH}$  intensities. If alkyl groups in the named compounds are replaced, partially or completely by phenyl, substituted phenyl or chlorine, then the wave-numbers as also the Raman and IR intensities are found to be influenced by the substituents. Consequent on hybridisation of 2nd order (inductive effect), the wave-numbers and Raman intensities rise with increasing electronegativity of the substituents whereas the infra-red intensities fall down. The  $\text{SnH}$  valence oscillation behaves,

as far as the present investigations allow, in a similar way. With the  $\text{SiCl}$  valence frequency, we can also notice a stronger influence of the substituents from the wave-numbers as well as from the intensities. Besides the hybridisation of the 2nd order, there is here the possibility for the formation of  $p\pi\text{-}d\pi$  compounds. Possibly these  $p\pi\text{-}d\pi$  compounds cause here a rise in wave-number and IR intensity with rise in electronegativity of the substituents, whereas the Raman intensity falls. Infra-red measurements show that here, the influence of solvent on the intensity is of the same order of magnitude as that of substituents. A similar influence should hold for Raman intensities. Therefore, it is necessary in future to make these measurements in dilute solutions.

In these investigations were engaged Mrs. Kessler and Messrs. Dube, Enge, Frei, Nillius, Reich, Schowtka and Ulbricht.

### 5. EXPERIMENTAL TECHNIQUES

*Construction and Performance of a Raman Apparatus with Grating and Excitation with Helium Lines* by R. Mecke, A. Schühly, of Freiburg and H. Stammreich, of Sao Paulo : An apparatus for the photography of Raman spectra is described. Excitation is by a helium lamp. Reports are given of the construction data, forming of the cold oxide electrodes, pressure of filling and also of the voltage requirements. The ratio of the intensity of the excitation line (5875 Å) to the background (at  $\Delta\nu = 400 \text{ cm}^{-1}$ ) is better than 30,000 : 1. The spectrograph with grating (1,200 lines/mm.) has a high light-gathering objective (aperture 1:1.6). The practical resolving power is at 1 Å, which can be utilized with the plates used (size  $18 \times 32 \text{ mm.}$ ). For isolation of the exciting line from the helium spectrum, use was made of a combination of filters, whose assembly and curves of transmission have been given. The problem of measuring and estimation of the line intensity, and the determination of their degree of depolarisation have been discussed.

*Improvements in Raman-Effect Techniques* by Bernhard Schrader and M. Stockburger, of Dortmund : One of the authors (B. Schrader, *Z. analyt.-Chemie*, 1963, 197, pp. 295-309) has recently described an arrangement using a low pressure mercury lamp and an interference filter condenser which has been found very useful in the photography of Raman spectra of crystal powders. The same illuminating arrangements

can be used also for the excitation of Raman spectra of liquids.

The back-scattering arrangement uses cuvettes from 1 to 2 metre length which are illuminated from one end. The Raman radiation which issues from the same end ( $180^\circ$  to the direction of excitation) is led through a strip-prism to the slit of the spectrograph. As the intensity of the excitation radiation in the cuvette can be easily measured, this back-scattering arrangement proves to be good for measurement of absolute value of Raman scattering coefficients. The small dead volume (the unilluminated liquid before the exit window) provides ideal conditions for the observation of resonance Raman effect.

The standard cuvettes are cylinders of 18 mm. length and 7 mm. diameter (0.7 ml.). They are fitted in a spherical mirror system similar to those used in Raman gas cuvettes. The mirror systems give a 10-fold intensity of Raman radiation as compared to cuvette without the system; there is no disturbance by radiation issuing from the cuvette walls.

The micro-cuvettes require a filling of 0.07 ml. The intensity of Raman radiation is sufficient for the photoelectric registration of spectra of badly scattering substances. The spectra of coloured crystal powders can be easily obtained with radiation from a ruby laser. The Raman spectra of *p*-nitroaniline (yellow) and *p*-nitro-*p'*-dimethylamino-stilbene (deep red) were obtained.

*A Comparison between Some Arrangements for Quick Photographic or Photoelectric Registration of Raman Spectra* by M. Delhaye, M. Bridoux, Mme Crunelle Cras, M. Migeon and M. Wallart, of Lille: A direct photoelectric registration speed of Raman spectra of a thousand  $\text{cm}^{-1}$  per second can be obtained with a time constant of a few milliseconds. This enables the recording of a restricted region of Raman spectrum, containing a few characteristic lines within a few tenths of a second. The exposures of broader spectral region can also be obtained by using image changers or image-intensifying tubes; here also the necessary time does not exceed a tenth fraction of a second if one uses a continuously working mercury, thallium or helium lamp. It is also possible to obtain a cinematographic record of a chemical reaction. The laser enables, in a very short time, a single photograph with a single shot; it is, however, not possible at present to obtain a quick series of photographic exposures.

## 6. INVESTIGATIONS OF MOLECULAR STRUCTURE

*Raman Spectra of Gaseous Primary Aliphatic Amines* by H. Wolff and H. Ludwig, of Heidelberg: Raman spectra were recorded with suitable arrangements of gaseous Methyl-, Ethyl- and *n*-Propyl amines at a dispersion of  $14\text{--}26\text{ cm}^{-1}$ . In NH valence region of methylamine, there were no bands of antisymmetric NH-valence vibrations even in the otherwise strongly recorded spectra. In NH-valence region of ethyl- and *n*-propylamine there were found, on the other hand, antisymmetric NH-valence vibration band at  $3411\text{ cm}^{-1}$  and not at  $3470\text{ cm}^{-1}$  as reported earlier. But the strong band at  $3425\text{ cm}^{-1}$  in the infra-red gives the actual position of the antisymmetrical vibrations. In CH-valence region, there were found, both in Raman and infra-red spectra of undiluted liquid-methylamine and methylamine solutions some 5 bands: The appearance of these bands also with gases supports the view that these bands, at least for the most part, arise from resonance of the overtones or combinations of the CH deformation vibrations with one another or with the fundamental CH-valence vibration.

Immediately near the exciting lines there were observed faint bands in the spectrum of methylamine. The separation of these agree, within experimental errors, with what the theory gives for the distance of rotation bands of the compound regarded as a symmetrical gyroscope under selection rule  $\Delta K = 0$  and  $\Delta J = 2$ . Accordingly these bands are set down as rotation bands. The neighbouring bands in the chain-oscillation regions of ethyl- and *n*-propylamine were ascribed to rotation isomers.

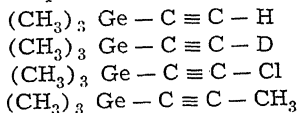
*Raman Spectroscopic Investigations on p-Benzoquinone and Isotopic Molecules* by H. Stammreich, of Sao Paulo, Brazil: The complete Raman spectra of *p*-benzoquinone and its centrosymmetric substituted isotope derivatives were observed in long wavelength spectral range by excitation with helium radiation  $5875.6\text{ \AA}$ . In addition to *p*-benzoquinone which is point group  $D_{2h}$  were investigated molecules  $\text{C}_6\text{D}_4\text{O}_2$ ,  $\text{C}_6\text{H}_4\text{O}_2^{18}$  and  $\text{C}_6\text{D}_4\text{O}_2^{18}$  as well as 2, 5- $\text{C}_6\text{H}_3\text{D}_2\text{O}_2$  which has symmetry  $\text{C}_{2h}$ . The comparative analysis of the observed spectra which include frequency, intensity and polarisation, allows a complete arrangement of all the 15 Raman active fundamental vibrations of the molecule under consideration. The circumstance that with symmetry class  $\text{C}_{2h}$ , the sub-groups  $A_g$  and  $B_{1g}$  of point group  $D_{2h}$  goes over into totally symmetric mode ( $A_{1g}$ ) leads us to the conclusion

that the spectrum of 2, 5- $C_6H_2D_2O_2$  is the key to the systematisation of the results. The last-mentioned compound has eleven total symmetries, also in Raman-effect polarised ground vibrations, while the higher symmetry molecule of  $D_{2h}$  structure has only 6.

In addition to the 15 Raman-active fundamentals there were numerous Raman bands observed which were very faint but which were undoubtedly first overtones, or binary combinations of type  $g-g$  or  $u-u$  and, therefore, as supplementing confirmation of the arrangement arrived at as regards the identification of the normal vibrations. Especially, the Raman bands were discussed which were observed in the region of  $C=O$  and  $C=C$  valence vibrations ( $1575-1715\text{ cm}^{-1}$ ). Here, we are to expect only two fundamental vibrations, which in a pure form correspond to vibration motions, however, strongly coupled with the nearby lying frequencies. Furthermore, in the spectra of all the molecules investigated a large number of broader lines, some of them of greater intensity, were found in this range. These were explained as due to resonance enhancement and to Fermi-doubling.

The classification arrived at of the frequencies and fundamental (grund) agree satisfactorily with what is to be expected from the Teller-Redlich rule of product-ratios.

*Raman and Infra-red Spectroscopic Investigations on Germanium-Acetylenes* by W. Steingross and W. Zeil, of Kiel: In continuation of previous investigations on the bonding properties of halogenated acetylenes the following compounds were synthesized and their Raman and infra-red spectra measured:



The position of the oscillations in the linear groups were especially discussed. The oscillations of  $C \equiv C -$  bonds lie at about the same frequencies as those found by us previously in the analogous silicon compounds.

The oscillations of  $Ge - C \equiv$  bonds lie, with the hydrogen compounds at  $497$ , and at  $485\text{ cm}^{-1}$ , with chlorine compounds at  $570\text{ cm}^{-1}$ . The carbon-chlorine-oscillation was to be seen at  $728\text{ cm}^{-1}$  and this has an appreciably higher frequency than in the case of carbon- and silicon-analogous compounds.

*The Raman Spectrum of Selenium Trioxide* by H. Gerding, Amsterdam, read out by C. C. Smitskamp: The results of an investigation by

Raman spectroscopy of mixtures of  $SeO_3$  and  $SO_3$  in molar ratio 1 : 4 were reported. The Raman spectra show the Raman lines of liquid  $SO_3$  with nearly unchanged frequency and intensity and in addition, the Raman lines of  $SeO_3$ -polymers. The Raman lines of solid  $(SeO_3)_4$  with point-symmetry group  $S_4$  (according to the X-ray diffraction measurements of Dr. Mylhof) were found to exist in the Raman spectrum of the solution. Besides  $(SeO_3)_4$ , there seem to be present also the oligomere of  $SeO_3$  or mixed compounds of type  $(SeO_3)_m(SO_3)_n$ . ( $n = m$ ,  $n \neq m$ ,  $n = 0$ ).

The decomposition of liquid selenium trioxide was accelerated through the irradiation.

*The Raman Spectra of Some Dialkyl-Aluminium Hydrides* by H. W. Schrötter and E. G. Hoffmann, of Mulheim, Ruhr: The Raman spectra of dimethyl-, diethyl, di- $n$ -propyl- and di-iso-butyl-aluminium hydride were registered with a "Cary" Raman spectrophotometer Mod. 81. The observed spectra are in agreement with the consequences of assuming a model having a point-group  $D_{3h}$  with plane (AlH)-ring. No deviation from such a model could be decided on with certainty. Most of the Raman lines were arranged in definite group vibrations. The very intense infra-red bands of AlH-valence vibration are extremely weak in the Raman spectrum. By stepwise addition of  $NEt_3$  to  $(Et_2AlH)_3$ , the Raman spectrum also exhibits strong AlH bands. They can be explained through the formation of intermediate complexes in the separation of AlH-ring, in the same way as in the explanation of observations made by DK-titration. In mixtures of  $(Me_2AlH)_2$  and  $Al(i-Bu)_3$  there occurs an exchange of alkyl groups. The Raman spectrum allows the proof of the formation of compounds  $Al_2Me_3(i-Bu)_4$  and  $Al_2Me_3(i-Bu)_3$  and gives an indication of the course of the reaction, which agrees with the results of calorimetric measurements.

*Raman Spectroscopy and the Structure of Aromatic Sulphur Compounds* by G. Kresze, of Munich, and E. Ropte and B. Schrader of Dortmund: Raman and infra-red spectra of methyl arylsulphides, -sulphoxides and -sulphanes having the general formula  $p-XC_6H_4SO_nC^*H_3$  ( $n = 0, 1, 2$ ;  $X = CH_3O, CH_3, H, Cl; NO_2$ ) have been recorded.

The assignment of the frequencies of the ring vibrations was determined by comparison with the known assignments of the mono- and  $p$ -substituted benzols. The ring vibrations below  $1000\text{ cm}^{-1}$  which are dependent on the substituents, show an approximate dependence on the

mass of the substituents. This is a useful guide for their assignment. On this mass dependence is superposed also, to a greater or lesser extent, the effects of the polar substituents. Above 1000  $\text{cm}^{-1}$ , there appears the ring vibration " $\nu(\text{C}_{ar}\text{-X})$ " as in the case of mono-substituted benzols  $\text{C}_6\text{H}_5\text{X}$ .<sup>12</sup> The *p*-substituted compounds  $p\text{-XC}_6\text{H}_4\text{Y}$  show the characteristic frequency  $\nu_{12}$  as in the case of  $(\text{C}_6\text{H}_4)\text{-X-}$  and the frequency  $\nu_{15}$  as in the case of  $(\text{C}_6\text{H}_4)\text{-}\gamma\text{-compounds}$

In the case of unsubstituted and *p*-substituted aryl sulphur compounds, these vibrations are independent of the state of oxidation of the sulphur, and appear as strongly polarised Raman lines and as strong infra-red bands at 1100-1080  $\text{cm}^{-1}$ . These frequencies can be taken as the characteristic " $\nu(\text{C}_{ar}\text{-S})$ " since the other ring vibrations, which depend on the substituents and which should give rise to a valence vibration by reason of the  $\text{C}_{ar}\text{-S}$  binding, exhibit a complex frequency dependence.

According to the assignment of the ring vibrations and of the known regions of  $\nu(\text{SO}_2)$ ,  $\nu(\text{SO})$  as also  $\delta(\text{CH}_3)$  in which they appear, the following are known characteristic frequencies of the sulphide-, sulphinyl-, and sulphonyl-groups which have been identified :

Sulphide :	$\nu(\text{CH}_3\text{-S})$ 730-710
Sulphoxide :	$\nu(\text{CH}_3\text{-S})$ 682-678
	$\delta(\text{CSO})$ 530-490 ; $\delta(\text{CSO})$ 370-350
Sulphane :	$\nu(\text{CH}_3\text{-S})$ 786-760
	$\delta(\text{SO}_2)$ 570-540 ; $\delta(\text{SO}_2)$ 535-515

The various frequency ranges of  $\nu(\text{CH}_3\text{-S})$  which arise essentially out of the  $\text{CH}_3$  group swinging against the sulphur respectively in the sulphides, sulphoxides and sulphanes can be stated only after a complete experimental evidence of the different structures of the  $\text{CH}_3\text{-S}$  binding in these three classes of substances is obtained.

*The Vibration Spectrum of Tetracyanoethylene (TCNA)* by E. Lippert and W. Lüder, of Stuttgart, and H. Moser and J. Varchmin, of Munich : Preparation : Chemically pure, coarsely crystalline TCNA was obtained for crystal powder spectra through repeated vacuum distillation on activated carbon. To obtain solution spectra, the TCNA was dissolved in acetoacetic ester ( $10^{-6}$  molar) and dichloromethane ( $10^{-7}$  molar).

Spectra : Infra-red spectra from 400-2600  $\text{cm}^{-1}$  were obtained on KBr-Tablets, and in solution by means of Beckmann IR9. Raman spectra from 50-2600  $\text{cm}^{-1}$  of tablets of the pure substance and of solutions were registered photoelectrically with a Steinheil Raman apparatus.

With the exception of a single oscillation of the crystal lattice at 87  $\text{cm}^{-1}$ , there was no difference noticeable between the spectra of solution and solid. The asterisked numbers were communicated by F. Miller of Pittsburgh.

#### Symmetry Groups $D_{2h}$

Species	IR, R	Wave-numbers, in brackets normal oscillations
$a_g$	R	2236 (CN), 1561 (C=C), 1280 (C-C), 541 (C-CN) 357 (CN-C-CN);
$b_{1g}$	R	416 (C-CN);
$b_{2g}$	R	510 (C-CN) 127 (CN-C-CN)
$b_{3g}$	R	2246 (CN), 682 (C-C), 596 (C-CN), 251 (CN-C-CN);
$b_{1u}$	IR	2258 (CN), 1154 (C-C), 578 (C-CN), 367* (CN-C-CN);
$b_{2u}$	IR	2222 (CN) 958 (C-C), 552 (C-CN), 165* (CN-C-CN);
$b_{3u}$	IR	428 (C-CN), 119* (CN-C-CN)

*Determination of Structure of Three Perchlorated Organic Compounds* by E. Ziegler, of Bamberg : With the help of Raman spectra and in part consideration of IR-spectra, the unknown structures of three perchlorated organic substances were investigated :

$\text{C}_6\text{Cl}_8$	..	(melting point 93° C.)
$\text{C}_6\text{Cl}_6$	..	( " 148° C.)
$\text{C}_8\text{Cl}_8$	..	( " 103° C.)

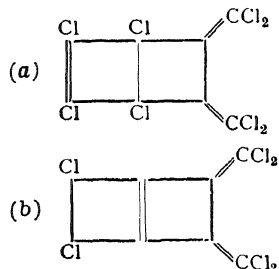
For the  $\text{C}_6\text{Cl}_8$ -compound, on the basis of the previous chemical investigations, a series of 5-ring and 4-ring structures were discussed as possible molecular structures. By the evaluation method of Herzberg, the number and polarisation of the expected lines of each of the structures, in various wave-number ranges, were obtained.

The wave-number and degree of depolarisation of the lines in the (C=C)- and (C-C)-range identify the compound as perchlor-(1, 2) dimethylcyclobutane.

Its dechlorinated product  $\text{C}_6\text{Cl}_6$  could be explained as perchlorodimethylene cyclobutane. The observed great scattering of (C=C)-wave-numbers (1536 p, 1620 dp, 1690 p) has been accounted for as due to strain in the ring of these structures.

For the  $\text{C}_8\text{Cl}_8$  combination, there were observed lines of higher intensities of (C=C)- (1488 p, 1693 dp, 1733 p) which lie well separated. On account of a large number of molecular structures which were obtained on chemical considerations, and on account of the wave-numbers and the symmetry considerations that

were carried out, only the highly strained structures (a) and (b) come into consideration.



Discussion and comparison of structure coefficients of (C=C)- lines with those corresponding in the  $C_6Cl_6$ -compound that have been observed enables the structure (b) to be decided upon as correct.

#### 7. VIBRATION SPECTRA OF CRYSTALS

*The Influence of the Internal Field on the Selection Rules for Raman Effect in Calcspat* by O. Theimer, of New Mexico: The intensity of the light scattering in crystals is determined by the effective polarisability  $\alpha^*$  determined.  $\alpha^*$  can be defined through the following equations:

$$\mu = \alpha E^* = \alpha^* E^0, \quad E^* = \gamma E^0, \quad \alpha^* = \alpha \gamma.$$

$E^0$  is the average macroscopic radiation field,  $E^*$  is the effective microfield at the position of the atom,  $\mu$  is the induced dipole moment.  $E^*$  is a linear function of  $E^0$ , but is not necessarily parallel to it.  $E^*$  has been calculated for the case of calcspat under the assumption that the  $CO_3$  ions rotate round the 3-fold axis and that the elastic waves are excited thermally. It is found that  $\alpha^*$  has a lesser symmetry than  $\alpha$  and the magnitude of the tensor component  $\alpha_{xy}^*$  depends on the direction of the incident and scattered rays of light. In this way the breakdown of the selection rules can be qualitatively clarified.

*The Classification of Vibration Spectra of Three Modifications of Thiourea by the Help of Factorgroup Analyses* by R. Fischer and B. Schrader, of Dortmund: The vibrating unit in crystals is the elementary cell. Therefore, the vibrations of a molecule in a crystal grating split up, at a maximum, into as many components as the molecule has in the elementary cell. The selection and counting rules are given by the factorgroup analysis. For the proving of the method, thiourea is very suitable since it has many modifications. The investigations dealt with the room temperature modification  $D_{2h}^{16}$ , the ferroelectric modification  $C_{2v}^{16}$  at

$-180^\circ C.$  as well as the closed compounds  $D_{3h}$ . The Raman spectra of these compounds and also of the deuterium substituted ones were obtained by the tablet method. The IR-spectra of them were also obtained, in part with monocrystalline layers and polarised radiation. The theory predicts splittings of molecular vibrations, as well as differences in frequencies, or coincidence in infra-red and Raman spectra. The prediction are fulfilled in most of the cases, and particularly well with the C=S- and with NH valency vibrations. Considerations of intensity distributions of the band components were taken as helping factors in systematisation. Raman spectra show, in the range below  $200 \text{ cm}^{-1}$ , lines which have their origin in the translational and torsional vibration of the rigid molecule. A classification could not, however, be arrived at.

#### 8. FORCE-CONSTANTS AND FREQUENCY CALCULATIONS

*A New Internal Valence Force Field for Benzene* by J. Duinker and I. Mills, Amsterdam: Recently Callomon, Dunn and Mills have measured and analysed rotational structure in the  $2600 \text{ \AA}$  band system of benzene and benzene- $d_6$  (to be published). They were able to determine the Coriolis zeta coefficients  $\xi_{6a,6b}$  for the two degenerate components of the ring angle deformation vibration  $\nu_6$  in the  $E_{2g}$  species of  $C_6H_6$  and  $C_6D_6$ . The values of the zeta coefficients are related to the force field governing the molecular vibrations, and they may be calculated from the L matrix, defining the form of the normal co-ordinates, and the C-matrix, a function of the masses and molecular geometry, as discussed by Meal and Polo.

We have calculated  $\xi_{6a,6b}$  for both Whiffen's valence force field and Scherer and Overend-Urey-Bradley force field. Neither reproduces the observed values satisfactorily, although the Urey-Bradley force field does better than the valence force field.

We have found a new force field for the planar vibrations of benzene to fit these new data in addition to the previously determined frequency data by a least squares refinement using programmes especially written for the Elliot 803 computer. Our force field is analogous to Whiffen's in that it is basically a valence force field, but our final values of the force constants, and the forms of the normal vibrations, are very different from his. We refined the force constants expressed in an internal coordinate representation, and in order to obtain

a unique solution we included only a limited selection of interaction force-constants, the latter being chosen by physical arguments based on the re-hybridisation of orbitals around the carbon atoms during the vibrations (hybrid orbital force field). The signs and magnitudes of these interaction constants, which were determined from the data by the force-constant refinement procedure, are in good agreement with theoretical expectations. Also the magnitude of the C—C stretching force-constant in our force field is  $7.02 \text{ md. \AA}^{-1}$ , in place of  $5.55 \text{ md. \AA}^{-1}$  in Whiffen's force field; our result is in better agreement with expectations based on bond order and bond length, and the known force constants for C—C single bonds (ca.  $5 \text{ md. \AA}^{-1}$ ) and for C=C double bonds (ca.  $10 \text{ md. \AA}^{-1}$ ). For all these reasons we regard our new force field as more reliable than Whiffen's force field.

Our calculations have been based on the Mair and Hornig assignment of the  $B_{2u}$  species vibrations, and our results strongly favour this assignment, in that the sign and magnitude of the interaction force-constant in the  $B_{2u}$  species cannot be made consistent with the other symmetry species using the Ingold assignment. We included a "Kekule" interaction force-constant between the CC stretching co-ordinates, of the type used by Scherer and Overend as a modification to their Urey-Bradley force field.

Finally we have transferred our force field to a number of related molecules: (1) halogenated derivatives of benzene, and (2) pyridine and its partially deuterated derivatives. We find that our benzene force-constants provide a good zero-order guess for the force field of these molecules, and that satisfactory force fields for these molecules can be obtained by making small modifications to the benzene force field around the substituent groups.

*Recent Calculations of Force-Constants* by W. Sawodny, Stuttgart: By one of the processes developed by A. Fadini, it is possible to deduce a force-constant theorem comprising all the coupling constants of the general valence-force model, making use of no other additional data than the vibration frequencies and the geometrical dimensions of the molecule. Thus, the normal frequencies are considered to be completely uncoupled in the first approximation. The well-known coupling of the kinetic energy is introduced step by step and the correction of the force-constant matrix  $F_k$  is computed by means of Newtonian treatment.

As the mathematical relation is very complicated, an attempt is made to elucidate the

application of the methods for obtaining the force-constant theorems by means of select and significant examples. The results show that the correction to  $F_k$  is very small. This implies that in the case of weakly coupled systems, the greatest changes occur along the diagonals of the  $F$ -matrix, while the coupling terms decrease very little in weight. The corrected and modified valence-force models obtained in such cases correspond to the general valence-force models. The non-diagonal terms of the  $F$ -matrix always become greater when the coupling of the normal vibrations is increased. So long as the normal vibrations are sufficiently characteristic the method can be effectively made use of. Only if the coupling is so strong that the vibration frequencies can no longer be predominantly associated with a symmetry co-ordinate, the method fails, which is not surprising, considering that a completely uncoupled system has been made use of as the starting point of the solution.

*Finalising Model Calculation with Electronic Calculating Machine PERM for Molecules  $H_2O$ ,  $D_2O$ ,  $HDO$ ,  $H_2O^{18}$  and  $D_2O$  and Ethylenes  $C_2H_4$ ,  $C_2D_4$  and Mixtures of Deuterium Isotoped Ethylene Molecules* by G. Strej, of Munich: By means of the comparative iteration method suggested by E. W. Schmid, the force-constants of the general potential form  $2V = \sum_{ij} f_{ij} t_i t_j$  for

$H_2O$  and  $C_2H_4$  have been determined. The vibration frequencies of  $H_2O$  and  $D_2O$  have been made use of in calculating the four force-constants of the  $H_2O$  molecule. The wave-numbers of  $HDO$ ,  $H_2O^{18}$  and  $D_2O^{18}$   $HDO^{18}$  have then been ascertained by means of the force-constants. The anharmonicities have been taken into account through a correction term of the atomic mass of the form  $m' = m(1 + c/\sqrt{m})$  ( $c = 0.08$ ). The accuracy of the experimental wave-numbers amounts to  $\approx 0.02$  to  $0.05 \text{ cm}^{-1}$ . The deviation of the calculated wave-numbers for  $H_2O$  and  $D_2O$  is  $0.5\%$  (ca.  $\pm 15 \text{ cm}^{-1}$ ) without the anharmonicity correction, and  $0.02\%$  (ca.  $\pm 0.6 \text{ cm}^{-1}$ ) with the correction. The correction term therefore improves the result by a factor of  $\approx 20$ . For the remaining isotopic water molecule, the deviations are as higher orders of the mass defects. The force-constant of ethylene molecule has been determined with the help of the two isotopic molecules  $C_2H_4$  and  $C_2D_4$ . Then, with these force-constants, the wave-numbers of the mixed deuterised ethylene have been determined, thereby confirming the order suggested in the literature. The deviation of the calculated wave-numbers from experimental values

is  $\approx 1\%$  (ca.  $\pm 30\text{--}40\text{ cm.}^{-1}$ ). This lies within errors of experiment.

The PED-values (PED: Potential energy distributions) have been given along with the modes of vibration.

Schmid's iteration method enables model calculations to be made for cases where not all the frequencies of a molecule are known without doubt provided we have simultaneously at our disposal the spectra of the isotopic molecules. Thus, in all, there are more well-determined frequencies than the number of force-constants to be calculated. The uncertain frequencies can be neglected in the iteration and subsequently they can be determined from the force-constants.

#### 9. OTHER INVESTIGATIONS

*The Temperature Dependence of Breadth of Raman Lines in Liquids* by U. Weber Munich: Investigations have been carried out in liquid  $\text{CCl}_4$ ,  $\text{SnCl}_4$ , benzol, cyclohexane, methanol and ethanol. The line breadth can be brought in close relation with the thermal behaviour of the

relaxation phenomena of the molecules in liquids theoretically investigated by Debye. The amount of widening is, in addition, dependent on the form of the profile of the line.

*The Quantitative Raman Analysis in Industries* by G. Matz, of Ludwigshafen: In the analytical application of Raman spectroscopy in industrial laboratory, we have to consider the special requirements of the analytical methods and hence the apparatus used should be designed not only for accuracy but also rapidity. An accurate apparatus is required and full instructions on the accessories which may be required for quantitative Raman analysis in industry. On the basis of a series of examples, the analytical problems which usually come across in the industrial laboratory have been considered. The quantitative Raman analysis of binary, ternary, and multicomponent mixtures have been discussed in detail. In the end there are two examples given of quantitative analysis of constitution.

## ADAPTATION OF GUINEA PIG TO ACETYLCHOLINE

JUSTYNA M. WISNIEWSKA\*

*Institute of Physiopathology, Medical School, Lodz, Narutowicza 60, Poland*

**P**ROBLEM of adaptation of animals to acetylcholine (ACh) has not as yet been studied despite the fact that (i) ACh plays an essential role in the electrical activity associated with nervous conduction<sup>1</sup> and it probably directly affects a cellular metabolism as inferred from the ACh-accelerated turnover of phospholipids<sup>2</sup> and ACh-stimulated synthesis of acetylcholinesterase (AChE)<sup>3</sup>; (ii) ACh, accumulated after the *in vivo* inhibition of AChE by AChE-competitive irreversible inhibitors, leads to hyperactivity,<sup>1</sup> decay of electrical activity in axons<sup>4</sup> and to death in a final analysis as the result of bronchial spasms,<sup>1</sup> and depression of respiratory reflex<sup>5</sup>; (iii) Too low level of ACh also reflects in disorder of the respiratory reflex<sup>6</sup>; (iv) Cold-blooded animals, adapted to low temperatures, showed an increased level of ACh<sup>7</sup> and enhanced activity of AChE in brain, body tissues and body fluids.<sup>7-8</sup>

Since the data mentioned under (iv) directly point to a possible participation of ACh-AChE system in the process of adaptation to cold, while data [(i)-(iii)] indicate the great physiological importance of ACh, experiments were carried out with the aim of testing of the ability of guinea pig to adapt to high doses of ACh.

*Material and method.*—200–400 g. (2–5-months-old) male guinea pigs were exposed once a day to ACh, applied in a form of aerosol.<sup>9</sup> The animals under examination react with typical symptoms of contraction of bronchi, which are very similar to those induced by histamine aerosol.<sup>10</sup> Guinea pigs have been taken out of the expositional chamber<sup>11</sup> in 3rd phase of provoked asthmatic-like attack, i.e., in the moment of bradypnea, expiratory dyspnea and inspiratory respiratory arrest. A time of exposition, passing between the moment of start of the first exposition to the moment of appearance of the 3rd phase of asthma symptoms was taken as a measure of the initial sensitivity of a given

\* On leave from Institute of Experimental Pathology, Polish Academy of Sciences, Warsaw, Poland.

animal to ACh ( $t_0$ ). After the single applications of ACh aerosols in successively increased concentrations, the initial dose-response curve (IDRC) was estimated for each animal. In a result of repeated expositions to ACh aerosol of a given concentration the actually observed time of exposition ( $t$ ) was considerably prolonged. A value of the ratio  $t/t_0$  was taken as a measure of the adaptation, i.e., the increase of tolerance to ACh.

Each type of test was carried out on 20 animals at least. Control animals were breeding together with the tested ones at 20–24° C., and their sensitivities to ACh were determined only twice, viz., at the start and at the end of experiment.

**Results.**—As can be seen from the data of Fig. 1, the initial ACh-sensitivity depends both on the age of animal and the concentration of aerosol. Guinea pigs well tolerate ACh aerosols in concentrations below 1%, and are very sensitive to aerosols more concentrated than 2%; ACh-sensitivity decreases with the increase of age of animal. IDRC is hyperbolic-like in shape: A range of concentrations of ACh comprised within the bend fragment of IDRC presents a zone of the optimal adaptability of guinea pig (ZOA) to ACh.

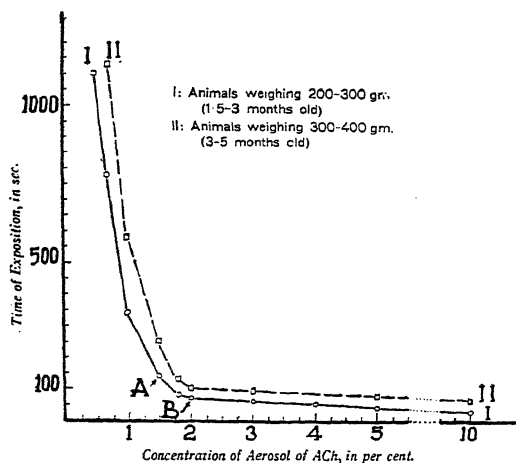


FIG. 1. Initial sensitivity (IDRC) of guinea pigs of different age to aerosol of acetylcholine. The bend fragment of IDRC, comprised within the arrows A and B, is zone of the optimal adaptability (ZOA).

On the basis of the data of Fig. 1 the animals, divided into three distinct groups, once a day were exposed either to 1.5, 1.8, or 2.0% ACh, respectively. In each case after 3 expositions the tolerance increased to 300–400% of the initial value (Fig. 2). After 18–20 treatments the animals could be regarded as fully adapted

to ACh aerosol of a given concentration. In this stage guinea pigs kept for 20 min. in the expositional chamber did not exhibit any symptoms of asthmatic-like attack. If animals were continuously shocked, i.e., if they were taken out of the expositional chamber in the 4th phase of asthmatic-like attack (staggering, unbalancing) they adapted to ACh slowly, and after 18 days their tolerance rapidly dropped (Fig. 2, Curve IV).

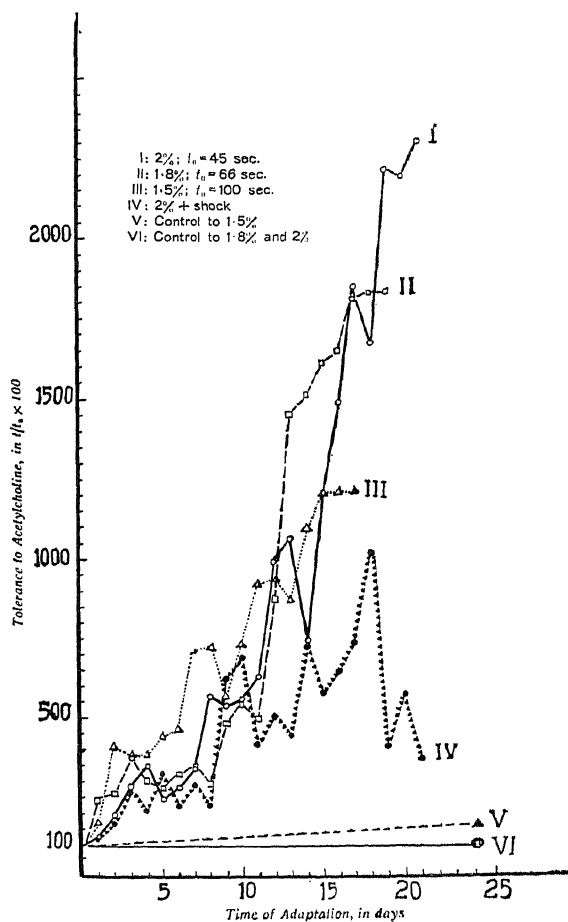


FIG. 2. Kinetics of adaptation of guinea pigs to 1, 5, 1.8 and 2.0 % aerosols of acetylcholine (Curves I, II and III, respectively). Permanently shocked animals do not adapt to ACh (Curve IV). 200–300 g. animals were under examination.

Animal adapted to a given concentration of ACh is not fully adapted to the higher one. It can be adapted, however, if it will be exposed to ACh aerosol of higher concentration comprised by the new ZOA. Figure 3 explains this assertion: After the IDRC has been determined (Fig. 3, Curve I), the animals were exposed to



1-8% of ACh. Full adaptation to the ACh aerosol was obtained even after 24 days, and then a new, not essential, but close to positive effect (ADRC) were determined (Fig. 3, Curve II). The animals were then exposed to 15% ACh aerosol, resulting in a marked reduction in the number of ZOAs at the end of 24 days. Within 13-21 days the animals were fully adapted to 15% ACh. ADRC was also determined (Fig. 3, Curve III) and the animals were fully ACh-adapted for the full adaptation of behavior after a treatment (ADRC) (Fig. 3, Curve IV). In this case revealed that there is no marked ZOAs at night

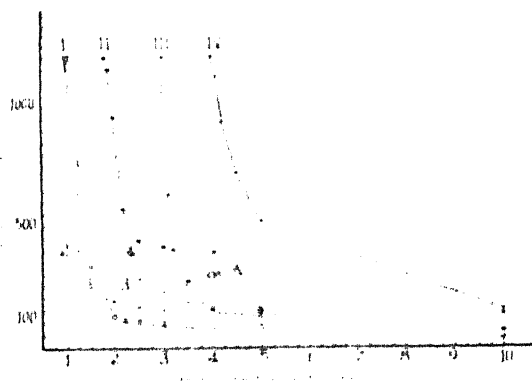


Fig. 3. Adaptation of guinea pig to ACh aerosol. 1) Initial weight curves (IDRC); II, III and IV) ADRC of animals adapted to 1-8% ACh aerosol; 1) control; 2) 15% ACh aerosol; 3) 15% ACh aerosol; 4) 15% ACh aerosol. After 24 exposures to 15% ACh adapted animals to 15% ACh, the tolerance decreased to 4% ACh dropped to a level of 100 ZOAs and A. Initial weight of animals equalled 500-600 g.

be inferred that the upper limit of the adaptability was reached. With the aim of testing of this assumption the guinea pigs were then exposed to 15% ACh aerosol. No increase of tolerance has been observed within the subsequent 7 exposures. Instead, a marked decrease of tolerance appeared. Moreover, in a result of such treatment the adaptation to 4% ACh was erased, i.e. tolerance decreased to the level of tolerance of animals adapted only to 3% of ACh (Fig. 3, Point A).

It is of interest to note that the increase of tolerance to ACh aerosol is not only restricted

to smooth muscles of bronchi but it comprises the whole organism as inferred from the facts: that (1) in response to intravenously injected ACh  $LD_{50}$  equalling 9 mg/kg. for non-adapted guinea pigs (control), rose to 14 mg/kg. for animals adapted to 1-8% of ACh; and (2) cysteine 2-3 times accelerated the process of ACh adaptation<sup>11</sup>; and (3) that in ACh-adapted animals activity of AChE is markedly increased. The latter finding supports an assumption that increase of tolerance to ACh in guinea pigs follows after the ACh-induced synthesis of AChE<sup>12</sup>.

In conclusion, guinea pig can be adapted to ACh applied in a form of aerosol. The upper limit of adaptation is achieved between 4 and 8% of ACh. Higher concentrations of ACh (above 4%) or permanent shocking suppress the adaptation, probably as a result of a general exhaustion of the animal.

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## LETTERS TO THE EDITOR

LATTICE THERMAL EXPANSION OF  
RUBIDIUM IODIDE AND CALCIUM  
SULPHIDE

THE results of an accurate measurement of the lattice parameters and coefficients of thermal expansion of rubidium iodide and calcium sulphide (both belonging to the sodium chloride structure) are being reported here.

The thermal expansion of rubidium iodide has been studied by Henglein<sup>1</sup> at low temperatures and by Baxter and Wallace<sup>2</sup> at ordinary temperatures by pycnometric methods. For the range 25°–50° C., Baxter and Wallace give a linear coefficient of  $30.1 \times 10^{-6}/^\circ\text{C}$ . which is much lower than the value  $39.7 \times 10^{-6}/^\circ\text{C}$ . given by Henglein for the range 79 to 0° C. An accurate re-determination was therefore considered desirable. For calcium sulphide, the coefficient of thermal expansion does not seem to have been measured.

The lattice parameters were determined by the X-ray powder diffraction method using a flat-film back-reflection camera. The technique used by Deshpande and Mudholker<sup>3</sup> had to be modified as, for both the substances, only one good reflection was available for measurement. Annealed powder of specpure Aluminium was sprinkled over the sample and composite photographs were taken. With the help of the composite photographs, the necessary correction was worked out for the lattice constant obtained from the single reflection by a procedure similar to that of Bacon.<sup>4</sup> The values of the lattice parameters and the observed coefficients of thermal expansion at different temperatures are given in Tables I and II.

TABLE I

Lattice constants of rubidium iodide and calcium sulphide at various temperatures

Rubidium iodide		Calcium sulphide	
Temp. °C.	<i>a</i> (Å)	Temp. °C.	<i>a</i> (Å)
27	7.3466 ±0.0002	26	5.6951 ±0.0002
69	7.3597	58	5.6970
93	7.3672	132	5.7032
119	7.3750	161	5.7051
173	7.3957	246	5.7128
..	..	293	5.7176

The room temperature value  $7.3466 \pm 0.0002$  Å for the lattice constant of rubidium iodide agrees with the value  $7.340 \pm 0.004$  Å quoted by Donnay and Nowacki.<sup>5</sup> Similarly the value

TABLE II

Coefficients of thermal expansion of rubidium iodide and calcium sulphide at different temperatures (in units of  $10^{-6}/^\circ\text{C}$ .)

Rubidium iodide			Calcium sulphide		
Temp. °C.	$\alpha$ (Obs.)	$\alpha$ (Calc.)	Temp. °C.	$\alpha$ (Obs.)	$\alpha$ (Calc.)
40	39.7	40.0	40	11.4	12.1
60	41.2	40.7	80	12.7	12.9
80	42.5	42.1	120	14.1	13.9
100	43.2	44.0	160	14.9	14.8
120	47.0	46.5	200	16.2	15.9
140	49.3	49.6	240	17.1	17.6
160	53.6	53.4	280	18.0	18.1

$5.6951 \pm 0.0002$  Å for the lattice constant of calcium sulphide agrees well with the value  $5.6950$  Å reported by Primak *et al.*<sup>6</sup>

It is found that over the range of temperature covered in each case the coefficients of thermal expansion follow the equations given below.

For RbI,

$$\alpha = \frac{1}{a_{25}} \frac{da}{dt} = 40.23 \times 10^{-6} - 3.81 \times 10^{-8} t + 7.46 \times 10^{-10} t^2$$

For CaS,

$$\alpha = \frac{1}{a_{25}} \frac{da}{dt} = 11.23 \times 10^{-6} + 1.93 \times 10^{-8} t + 0.18 \times 10^{-10} t^2$$

The mean coefficient of thermal expansion of rubidium iodide for the range 25–50° C. is  $40.1 \times 10^{-6}/^\circ\text{C}$ . as against the value  $30.7 \times 10^{-6}/^\circ\text{C}$ . given by Baxter and Wallace. It may be pointed out that the increase in the coefficient of thermal expansion of rubidium iodide with temperature is greater than that in rubidium chloride and rubidium bromide as reported by the authors<sup>7</sup> elsewhere.

Department of Physics, D. B. SIRDESHMUKH.  
Univ. College of Science, V. T. DESHPANDE.

Osmania University,  
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# THE CRYSTAL AND MOLECULAR STRUCTURE OF ARSENIC TRIBROMIDE AT $-10^{\circ}\text{C}$ .

ARSENIC TRIBROMIDE is a hygroscopic yellowish-brown oily liquid at room temperature. A small quantity of this liquid was sealed in a Lindemann capillary and using the low temperature camera developed by Singh and Ramaseshan (1964), a single crystal was grown. The  $hk0$ ,  $hk1$  and  $hk2$  reflections were recorded by the multiple film technique.

could not be recorded. The prominent peaks in the Patterson-Harker section at  $W=1/2$  enabled the crystal to be assigned the space group  $P2_12_12_1$ .

As the four atoms have nearly equal atomic number ( $\text{As} = 33$ ,  $\text{Br} = 35$ ) the heavy atom method could not be used.

The approximate co-ordinates in the  $hk0$  projection were obtained from the Harker-Patterson section at  $W = 1/2$ . The  $hk0$  electron-density projection is shown in Fig. 1.

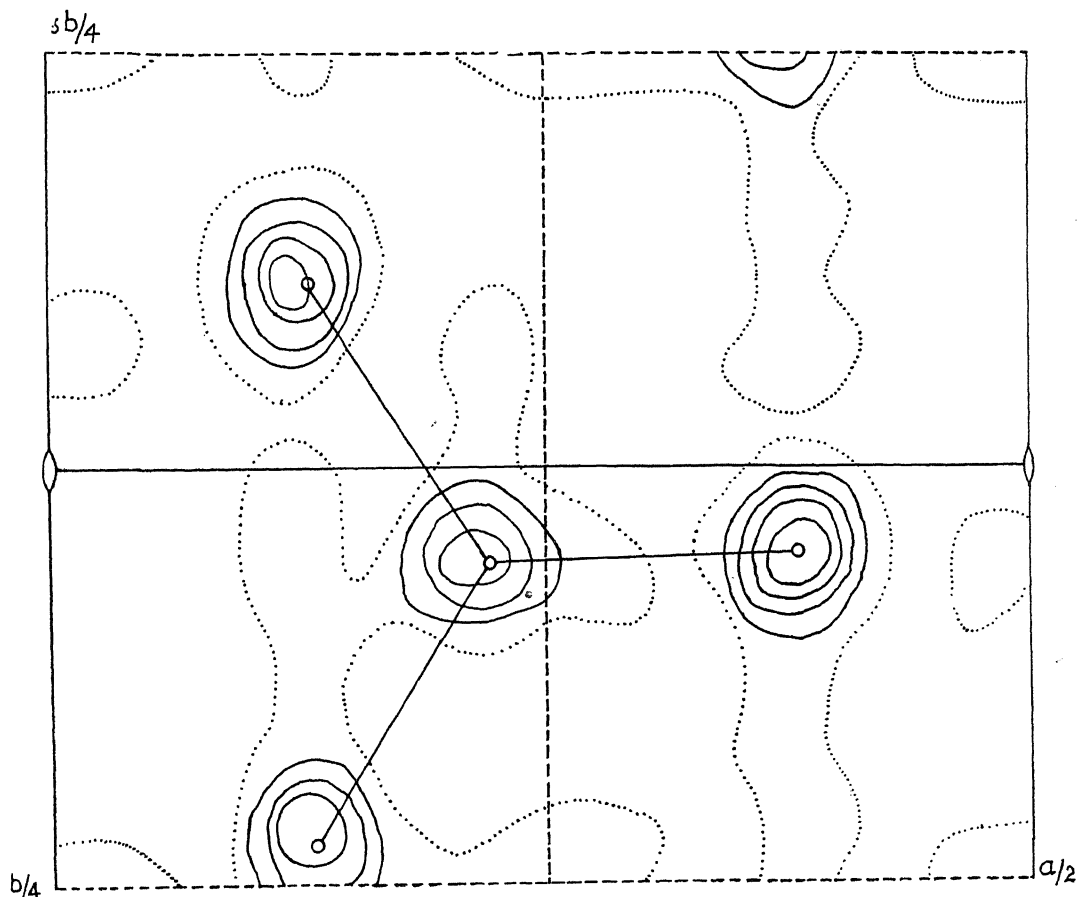


FIG. 1

The crystal belongs to orthorhombic system with cell dimensions

$$a = 12.148 \text{ \AA}, b = 10.244 \text{ \AA}, c = 4.34 \text{ \AA}.$$

The Weissenberg photographs taken about  $c$  axis indicated the space group to be either  $P2_12_12_1$  or  $P2_12_12$ . The ambiguity could not be resolved directly as the crystal did not grow along any other axis and the  $00l$  reflections

The  $z$  co-ordinates were estimated from generalised Patterson projection using  $hk1$  reflections. The  $R$  factors ( $= \sum ||F_0| - |F_c|| / \sum |F_0|$ ) for  $hk0$  and  $hk1$  and  $hk2$  reflections, at this stage were .25, .45 and .60 respectively. By trial adjustment of the  $z$  co-ordinates, the  $R$  factor for all the reflections (including unobserved reflections) was reduced to .23.

The approximate co-ordinates are given below.

	x	y	z
Br (1)	·37	·61	0
(2)	·39	·26	0
(3)	·635	·45	0
As	·465	·44	·25

The molecule is pyramidal, with the bromine atoms at the vertices of an equilateral triangle forming the base of the pyramid, and arsenic at a height 1·08 Å above the plane of the bromine atoms.

The refinement of atomic and temperature parameters is in progress.

The authors are grateful to Prof. S. Ramaseshan, Head of the Physics Department, Indian Institute of Technology, Madras, for the guidance and encouragement. Thanks are due to the Council of Scientific and Industrial Research of India for sponsoring the scheme on Low and High Temperature Crystallography and for the award of the Research Fellowship to one of the authors (A.K.S.). Thanks are also due to Prof. B. R. Pai of the Presidency College, Madras, for the sample of  $\text{AsBr}_3$ .

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### ACTION OF MAGNESIUM CHLORIDE ON ALCOHOLS

Magnesium Chloride reacts with alcohols in cold benzene forming the hexa-alcoholates  $\text{MgCl}_2 \cdot 6\text{ROH}$  where  $\text{R} = \text{Me}$ ,  $\text{Et}$ ,  $\text{Pr}^n$ ,  $\text{Pr}^i$ ,  $\text{Bu}^n$ ,  $\text{Bu}^i$  and  $n$ -pentyl. Heating the alcoholates to  $60^\circ\text{C}/0\cdot1\text{ mm.}$  formed magnesium chloride tetra-alcoholates and heating to  $120^\circ\text{C}/0\cdot1\text{ mm.}$  formed magnesium chloride dialcoholates.

Simon<sup>1</sup> found that the methyl and ethyl alcoholates of magnesium chloride conformed to the formula  $\text{MgCl}_2 \cdot 6\text{ROH}$ . The reactions of other alcohols on magnesium chloride have not yet been studied. It was found in this investigation that anhydrous magnesium chloride reacted with methyl, ethyl,  $n$ -propyl, isopropyl,  $n$ -butyl, isobutyl and  $n$ -pentyl alcohols to give compounds which conformed to the general formula  $\text{MgCl}_2 \cdot 6\text{ROH}$ .

Anhydrous magnesium chloride was prepared by heating the hydrated salt to  $200^\circ\text{C}$ . in presence of dry  $\text{HCl}$  gas; the compound was also prepared by the azeotropic dehydration of the hydrated salt, benzene being added to the

appropriate alcohol to form the ternary azeotrope.

To magnesium chloride (4 g.), benzene (50 g.) and ethyl alcohol (50 g.) were added dropwise and a vigorous reaction took place. After cooling, the solution was evaporated to dryness under reduced pressure. A white paste was obtained to which benzene (10 g.) was added and the solution again evaporated to dryness. A white solid (6 g.) was obtained. On analysis the solid was found to be  $\text{MgCl}_2 \cdot 6\text{ROH}$ .

Other alcoholates were similarly prepared by the action of anhydrous magnesium chloride on the appropriate alcohol. The higher alcoholates were also prepared from hexa-ethyl and hexa-isopropyl alcoholates by alcohol interchange method.<sup>2</sup>

The hexa-ethyl alcoholate was heated to  $60^\circ\text{C}/0\cdot1\text{ mm.}$  The resulting compound on analysis was found to be magnesium chloride tetra-ethyl alcoholate. Heating was then continued at  $120^\circ\text{C}/0\cdot1\text{ mm.}$  The resulting compound on analysis was found to be a dialcoholate. Heating was then continued to  $180^\circ\text{C}/0\cdot1\text{ mm.}$  and the compound was found to conform to magnesium monochloromonoethoxide. Heating to  $220^\circ\text{C}/0\cdot1\text{ mm.}$  left a residue of magnesium hydroxy chloride.

All the alcoholates described above easily undergo hydrolysis and the usual precautions had to be taken to exclude moisture.

Department of Chemistry, R. K. MULTANI.  
Hans Raj College, University of Delhi,  
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### PAPER CHROMATOGRAPHIC SEPARATION OF TITANIUM, THORIUM AND CERIUM OR ZIRCONIUM, THORIUM AND CERIUM

THE possibility of utilizing simple inorganic solvents in paper chromatography of inorganic cations has been studied comparatively recently.<sup>1-5</sup> The authors have tried simple inorganic solvents and the results are presented in this communication when successful separation has been achieved.

Untreated Whatman No. 1 filter-paper strips (size  $1\cdot0 \times 20\cdot0$  inches) were used and the strips were irrigated for 3 hours at a temperature of  $25 \pm 1^\circ\text{C}$ . All the solvents used were of

analytical reagent quality. Nitrates of zirconium and thorium, chloride of titanium and sulphate of cerium (1 gm. of the salt in 100 ml. of distilled water) were used as the test solution. The development of the chromatograms was carried out by spraying them with saturated solution of alizarin in 96% alcohol and exposing them to ammonia and acetic acid vapours respectively. Titanium and zirconium gave purple, thorium blue-violet and cerium violet-coloured spots.

The following solvents were tried :

1. HCl — 2N — 0.05 N
2. HNO<sub>3</sub> — do.
3. H<sub>2</sub>SO<sub>4</sub> — do.
4. NaOH — 4N — 0.2 N
5. NH<sub>4</sub>OH — 8N — 0.2 N
6. Salts — Na<sub>2</sub>CO<sub>3</sub>, NaCl, NaNO<sub>3</sub>  
and Na<sub>2</sub>SO<sub>4</sub> 4N — 0.2 N
7. Salt and alkali mixture—Saturated solutions of NaCl, NaNO<sub>3</sub>, NH<sub>4</sub>NO<sub>3</sub> and NH<sub>4</sub>Cl were mixed with different amounts of ammonium hydroxide and sodium hydroxide.

But all except N sodium carbonate were found to be unsatisfactory. The R<sub>f</sub> values obtained were Ti 0.00, Zr 0.00, Th 0.94 and Ce 0.84 which resulted in a good separation of titanium, thorium and cerium or zirconium, thorium and cerium. The separation seems to be facilitated by the difference in solubilities of these compounds. The resolution of a mixture of Ti, Th and Ce or Zr, Th and Ce has been successfully accomplished by the present method.

The authors are thankful to Sri Rabinder-Nath for his help in earlier work. They also wish to express their sincere thanks to Dr. R. N. Singh for providing facilities.

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## FLAVONOIDS OF THE FLOWERS OF *HIBISCUS ABELMOSCHUS* AND *ALTHAEA ROSEA*

IN continuation of our earlier work on the flavonoids of South Indian Plants<sup>1</sup> in general and of the *Hibiscus* species<sup>2</sup> in particular, we have now chemically investigated the yellow flowers of *Hibiscus abelmoschus*<sup>3</sup> (Malvaceæ) whose pigments do not seem to have been studied so far. The flowers of *Althæa rosea*<sup>4</sup> (Malvaceæ) have been earlier reported to contain cyanidin<sup>4</sup> and a mixture of delphinidin and malvidin<sup>5</sup> with no mention of the anthoxanthins present. Hence, it was considered desirable to re-examine them.

*Hibiscus abelmoschus*.—The yellow portions of the petals of *H. abelmoschus* (collected in December, 1963 from Moovattupuzha, Kerala State) were extracted with methanol and the aq. methanolic concentrate was shaken with petroleum ether (40–60°) and ether. The ether concentrate on paper chromatography indicated the presence of myricetin. The aq. layer on keeping in an ice-chest for about two weeks yielded some yellow solid which after recrystallisation from methanol-ether came out as yellow needles, m.p. 240–43° (earlier sintering at 195°). The pigment gave an olive green colour with alc. ferric chloride and developed a bright yellow colour in the Hörhammer-Hänsel test suggesting a free hydroxyl group in the 3-position. On paper chromatography and exposure to ammonia, it developed a deep yellow spot having R<sub>f</sub> values (ascending) 0.23 (phenol sat. with water), 0.35 (butanol : acetic acid : water = 4 : 1 : 5), 0.30 (butanol : acetic acid : water = 4 : 1 : 2), 0.40 (60% acetic acid), 0.15 (15% acetic acid), 0.45 (ethyl acetate : formic acid : water = 10 : 2 : 3), 0.43 (acetic acid : HCl : water = 30 : 3 : 10) and (circular) 0.40 (phenol sat. with water) and 0.81 (water sat. with phenol).

The pigment on acid hydrolysis yielded myricetin (identified by its R<sub>f</sub> values and comparison with an authentic sample) and glucose (identified by paper chromatography). From the m.p. of the glycoside, its colour reactions and hydrolytic products, it was considered to be cannabicitrin. A direct comparison including co-chromatography of the pigment was also made with the myricetin glucoside isolated from *H. cannabinus*.<sup>6</sup> Since the two were identical, it was concluded that the glycosidic pigment of *H. abelmoschus* was cannabicitrin.

The purple portions of the petals were studied for anthocyanidins according to the method recorded earlier<sup>7</sup> and the aglycone was found to be only cyanidin as in the case of *H. tilicæus*,<sup>7</sup> *H. coccinea* and *H. moschata*.<sup>8</sup>

*Althæa rosea*.—Fresh flowers of *A. rosea* (from a garden in Pondicherry) were collected during March, 1963 and the major purple portions of the petals and the minor yellow portions were separately studied. The flavonoids present in the yellow portions were extracted with methanol, and the pigments in the concentrate purified by paper chromatography on a preparative scale.<sup>9</sup> The four zones that developed (butanol:acetic acid:water = 4:1:5, descending) were cut, eluted with methanol and individually studied by paper chromatography. From the R<sub>f</sub> values in different solvent systems and comparison with authentic samples, the pigments were identified as quercetin, kempferol, isoquercitrin and kempferol-3-glucoside.

The purple region of the petals was extracted with 0.01 N. ethanolic hydrochloric acid and studied by paper chromatography. The 3-glucoside and 3-rhamnoglucoside of cyanidin could be identified by R<sub>f</sub> values in different solvent systems and maximum absorption ( $\lambda_{\text{max}}$  540 m $\mu$ . in 0.01 N. ethanolic HCl), the values agreeing well for these compounds.<sup>10</sup> They were separated by large-scale paper chromatography (R<sub>f</sub> 0.47 and 0.59 in butanol:acetic acid:water = 4:1:5) and the two zones were eluted and boiled with 2 N aq. HCl for 30 minutes; the lower zone yielded cyanidin and glucose, and the other cyanidin, glucose and rhamnose. The total anthocyanidin estimated according to the method of Nash *et al.*<sup>11</sup> was found to be 13.5% (dry basis) in terms of cyanidin.

It may be mentioned that *H. abelmoschus* resembles *H. cannabinus*<sup>6</sup> in its flavonoid pattern to have myricetin (and its glucoside) formed by oxidation in the side phenyl of the basic flavonol quercetin and differs from *H. tiliaceus*,<sup>7</sup> *H. vitifolius*,<sup>12</sup> *H. surattensis*,<sup>7</sup> *H. sabdariffa*<sup>13</sup> and *H. esculantres*<sup>14</sup> whose major pigment is gossypetin (and its glycoside) formed by oxidation in the benzopyrone part of quercetin. *A. rosea* is one more example of the plants reported<sup>15</sup> to exhibit co-occurrence of the corresponding glycosides of flavonol and anthocyanidin.

We wish to thank Mr. A. Balasubramanian for technical assistance.

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Pondicherry, S. NAGARAJAN.  
March 28, 1964. S. SANKARA SUBRAMANIAN,

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#### OCCURRENCE OF LYCORINE IN THE ROOTS OF *HIPPEASTRUM RUTILUM* HERB.

*Hippeastrum rutilum* belongs to the family Amaryllidaceæ. This plant is said to have medicinal properties. The bulbs of the plant were investigated by Boit *et al.*<sup>1</sup> They reported the isolation of galanthamine, hæmanthamine, hippeastrine, homolycorine and lycorine. The roots of this plant form half the bulk of the bulbs of the plant and no work on this part of the plant seems to have been done. Hence the chemical examination of the roots has been taken up. The extraction procedures were more or less the same as those used by Hunger and Reichstein.<sup>2</sup> The material was minced and extracted with alcohol. The alcoholic extract was concentrated, shaken with lead hydroxide, filtered and adjusted to pH 6. The filtrate was further concentrated and extracted with petroleum ether (A), ether (B), chloroform (C) and chloroform-alcohol (2:1) (D). The remaining concentrate was made alkaline to litmus and again extracted with chloroform (E) and chloroform-alcohol (2:1) (F). From the extracts C, D, E and F a crystalline substance (140 mg.) (0.0044%), m.p. (crude substance) 252–54° (decomp.) was obtained.

The identity of the crystalline substance was established, as lycorine, by the following pro-

perties, m.p. 260–62° (decomp.)  $[\alpha]_D^{30} = -101.2^\circ \pm 2^\circ$  ( $c = 0.441$  in absolute alcohol). It analysed for the formula  $C_{16}H_{17}NO_4$ ; Found: C, 66.5; H, 6.5; N, 5.1%. The acetate was prepared in the usual way with pyridine and acetic anhydride, m.p. 214–16°, and analysis agreed for the formula  $C_{20}H_{21}NO_6$ ; Found: C, 65.0; H, 6.1; N, 4.2%. A mixed m.p. of this with the alkaloid acetate obtained from *Crinum deflexum* was undepressed. Hydrochloride was prepared by the usual way, m.p. 222–24°. Thus the crystalline substance was proved to be identical with lycorine.

Our thanks are due to the Curator, National Botanical Gardens, Calcutta, for the identification of the original plant material and our thanks are also due to the University authorities for providing facilities.

Dept. of Pharmacy, R. V. KRISHNA RAO.  
Andhra University, (MRS.) VIMALA DEVI.  
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## DIFFERENTIAL THERMAL ANALYSIS OF BRAZILIAN MINERALS

### III. Meta-Strengite

MENTION of the occurrence of meta-strengite (phosphosiderite) is made in literature, though no study of the differential thermal analysis is known. Meta-strengite and vivianite are isostructural, and they differ in water content, the former having two and the latter eight molecules of water.

Dehydration studies on the mineral with X-ray identification were made on the samples from Boqueirao Pegmatite near Parelhas town of the Rio Grande do Norte state by the author (1960). In this study several samples from the above pegmatite, and also from the Patrimônio Pegmatite near Pedra Lavrada of the Paraíba state, have been studied by the differential thermal analysis method, after X-ray identification.

The d.t.a. set used here is an Eberbach Portable type, with the heating rate controlled to a 20° C./min. by the authors (1961). Four samples each from the above pegmatites gave the average results as shown in Table I.

Manly (1950) refers to the d.t.a. curve of vivianite and explains that the endothermic

TABLE I

Locality	Intensity of curve	Peak temperature in °C.	
		Endothermic	Exothermic
Boqueirao Pg. ..	Very weak	140 ± 10	..
Pegmatite ..	Strong	240 ± 10	..
	Medium	..	570 ± 10
Patrimônio ..	Strong	250 ± 10	..
Pegmatite ..	Medium	..	580 ± 10

peaks represent the loss of five, two and one molecule of water at 230° C., 330° C., and 380° C. respectively. The exothermic peak at 550° C. of vivianite is considered to be due to the oxidation of ferrous iron to the ferric state.

Meta-strengite can be explained in the same way. The endothermic reaction peaking at 140° C. given in the samples of Boqueirao Pegmatite, and absent in the others, is due to the loss of absorbed water. The endothermic peak at 250° C. is due to the break of structure and the loss of total water content. The exothermic peak at 580° C. represents the oxidation of ferrous iron. Similarities are also noted between the d.t.a. and dehydration curves of the mineral.

The final product at 1000° C. when X-rayed showed lines corresponding to those of maghemite and  $FePO_4$ .

Details are under publication in Brazilian journals.

A. BHASKARA RAO.

JUDSON DA CUNHA E SILVA.

Escola de Geologia de  
Pernambuco,  
Dept. de Mineralogia e Petrografia,  
Universidade do Recife,  
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Added in proof

The authors have received the work of Correia Neves (1960) since the despatch of the paper, where D.T.A. curve of phosphosiderite is included with endothermic peaks at 115° (weak), 290° (very strong), 758° (weak) and exothermic peaks at 630° (medium) and 875° (weak), con-

cluding that the exothermic peak is indicative of tridimetic structure. There is no agreement in the data obtained by the authors and Correia Neves (op. cit.).

Reference: Correia Neves, J. M., "Pegmatitos com berilo, columbite, e fosfatos-tantelita da Bendada (Sabugal, Guarda)," *Mem. e Not., Mus. e Lab. Mineral. e Geol., da Univ. da Coimbra e do Centro de Estudos Geol.*, 1960, No. 50, 169 pp.

### A NOTE ON THE FOOD OF THE OYSTER, *CRASSOSTREA GRYPHOIDES* (SCHLOTHEIM)

THE food of the edible oyster has been extensively worked out.<sup>1-7</sup> Organic detritus, bacteria and diatoms have been found to contribute mainly to the oyster food. In India, the Madras backwater oyster, *Ostrea* (*Crassostrea*) *madrasensis*, has been observed to feed on certain diatoms.<sup>8-9</sup>

Food of the backwater oyster *Crassostrea gryphoides* from the Bombay coast was investigated by pipetting out the contents from the stomachs of 20 actively feeding oysters, every fortnight, for a period of thirteen months. The stomach contents thus obtained were analysed microscopically and arbitrary units such as rare, occasional, common and plenty were used to estimate quantitatively, each item of food.

It was found that detritus was present in the food in more or less quantity throughout the year. It was plenty from March to May and also from September to November and low from June to August.

The diatoms in the food belonged to 20 different genera, out of which *Coscinodiscus*, *Thalassiosira*, *Biddulphia*, *Cocconeis*, *Achnanthes*, *Diploneis* and *Synedra* appeared to form the major portion. No diatoms occurred in the food during S.W. monsoon, i.e., from June to August, when the detritus content was also low. In fact, during this period, the stomachs were invariably found empty. This retardation in feeding may perhaps be due to the low salinity prevailing during monsoon.<sup>10</sup> This time of the year also corresponds with the spawning period of this oyster. The feeding activity of *C. gryphoides* on diatoms was observed to increase from October, immediately after spawning and it was at its peak from December to February, the months when oysters were in the best state of their health.

The absence of protozoan and metazoan animals, in the food of oyster under investigation, was very conspicuous. A nauplius was

noted once, while some damaged crustacea and their appendages were observed only twice in the food. Lotsy<sup>11</sup> and Korringa<sup>12</sup> observed protozoan and metazoan animals and their remains in the food of oysters. However, the latter author suggested that the animal food leaves the oyster's gut unchanged.

From this study it appears that, though detritus and diatoms both contribute to the food of the oyster *C. gryphoides*, the diatoms and especially those belonging to the genera referred to above, appear to be more responsible for its recovery from spawning and its subsequent fattening. It may be mentioned that Savage<sup>7</sup> attributed the fattening of oysters to diatoms and particularly to the genus *Nitzschia* while Nelson<sup>13</sup> considered *Skeletonema costatum* as the most valuable diatom in the nutrition of oysters.

Department of Zoology,  
Institute of Science,  
Bombay, February 3, 1964.

V. S. DURVE.\*

\* Present address: Central Marine Fisheries Research Institute, Mandapam Camp.

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### OCCURRENCE OF TWO STRAINS OF JUTE MOSAIC VIRUS IN UTTAR PRADESH

FINLOW<sup>1</sup> reported a chlorosis of jute in Bengal which was not transmissible by sap. He, therefore, concluded that it was not of virus origin. Ghosh and Basak,<sup>2</sup> however, transmitted it by grafting and suspected that the chlorosis was caused by a virus.

During July 1963, about 10% jute plants showed symptoms of mild and severe mosaic at the Jute Research Station, Goghraghat, Uttar Pradesh. The mild mosaic symptoms were characterised by a general yellowing of the



leaves with a few interspersed green areas and a yellow banded appearance of the tertiary veinlets. Sometimes chlorotic flecks occurred adjacent to the primary and secondary veins. The symptoms were more marked in older plants which remained normal in size. The severe mosaic symptoms were accompanied by stunting of plants with small pale yellow leaves with green areas confined to the main veins of the leaf lamina which was often crinkled and crumpled. The affected plants did not flower and if a few flowers were produced, there was no seed-setting.

Since *Corchorus capsularis* was more susceptible than *C. olitorius*, it was used for further tests. Thirty scions of *C. capsularis* showing severe and mild symptoms when grafted on thirty healthy plants of the same species showed the result as given in Table I.

TABLE I  
Transmission of virus from plants showing  
severe and mild symptoms

Scions from affected plants	Grafted plants showing		
	Mild mosaic	Severe mosaic	Dead
Mild symptoms	.. 27	2	1
Severe symptoms	.. 5	16	9

Cross protection tests were carried out with scions from plants showing severe mosaic being regrafted on the 27 plants showing symptoms of mild mosaic but no change of symptoms was observed throughout the life of the infected plants. Similarly scions from the mild mosaic-affected plants were grafted on the 2 severe mosaic-affected plants obtained by grafting scions from the apparently mild mosaic-affected plants to the healthy plants. There was no change of symptoms in the shoots of the originally severe mosaic-affected stunted plants whereas the scions of the mild mosaic continued to grow vigorously as usual. This showed that two strains of the same virus were involved in causing the chlorosis of jute.

The two strains of the jute mosaic virus were successfully transmitted by *Bemisia tabaci* Gen. but not with *Myzus persicae* Sulz. and *Aphis gossypii* Glover.

Host range tests carried out with a number of genera by grafting infected scions of mild and severe strains of *C. capsularis* indicated that they were transmitted only to *Hibiscus subdariffa* L. and *H. cannabinus* L. When scions from these symptomless plants were grafted on the healthy *C. capsularis* plants, no symptoms

developed showing thereby that they were not symptomless carriers of the jute mosaic virus.

Laboratory of Plant Pathologist. N. S. BISHT.  
to Government, R. S. MATHUR.  
Uttar Pradesh, Kanpur,  
February 14, 1964.

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# **PYRENOCHAETA ACHYRANTHIDIS** **SP. NOV. ON ACHYRANTHES ASPERA L.** **IN INDIA**

*Achyranthes aspera* L. (Hindi : latjira, chirchira, chirchitta) is a common perennial weed of great medicinal value in India. The seeds of this herb contain the hydrocarbon hentriacontane and the saponin as oleanolic acid-oligosachcharides.

In August, 1963, severe leaf-spotting of this host was observed at the Government Agriculture College Campus, Kanpur, which on microscopic examination revealed the presence of a new species of *Pyrenochaeta* belonging to the family Sphaeropsidaceae of the Deuteromycetes.

*Morphology of the fungus*.—Leaf spots circular to irregular, pale to dark brown with almost dirty white centre and dark brown margins, 2–10 mm. diam. (Fig. 1); pycnidia punctiform, dark brown, reticulate, globose, separate, innate later on more or less erumpent ranging 65.64–161.84 × 57.12–412.8 μ, but mostly 130 × 93.4 μ in diam.; ostiolate, pore about 16 μ broad surrounded by 2–8 dark brown 1–6 septate setae, straight to slightly curved, broader at the base and slightly narrower towards the tip, obtuse, hyaline, ranging 36.7–135.4 × 3.24–5.40 μ; sporophores not visible; spores ellipsoid to fusoid, hyaline, 1-celled, straight, both ends obtuse 4.8–6.7 × 1.4–1.9 μ in size, 2-guttulate, spores coming out in a gelatinous mass on rupturing and in a cirrus through the ostiole (Fig. 2).

On living leaves of *Achyranthes aspera* L. (Amarantaceae), Kanpur, Uttar Pradesh, India, August, 1963, L. S. Chauhan and S. C. Verma.

*Pyrenochaeta achyranthidis* Mathur, Chauhan and Verma *Foliorum maculae circulares vel irregulares, pallide vel fusce brunneae, medio fere sordi de albo, margine fusce brunneo*, 2–10 mm. diam.; pycnidia punctiformia, fusce brunnea, reticulata, globosa, distincta, innata, postea vero plus minusve erumpentia, 66.64–



FIG. 1. Leaf of *Achyranthes aspera* L. showing pycnidia within spots.

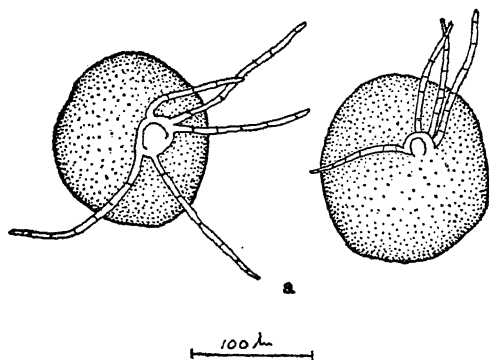


FIG. 2 (a). Pycnidia of *Pyrenopeziza achyranthidis* on *Achyranthes aspera* L.

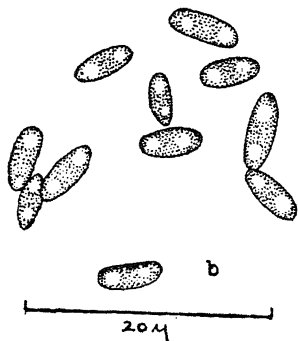


FIG. 2 (b). Spores.

161.84  $\times$  57.12–412.8  $\mu$ , sed vulgo 130  $\times$  93.4  $\mu$  diam.; ostiolata, poro ca. 16  $\mu$  lato circumdato setis 2–8 fusce brunneis 1–6 septatis rectis vel paulum curvatis ad basin latoribus, paulo angustioribus et apicem, obtusis, hyalinis, 36.7–135.4  $\times$  3.24–5.40  $\mu$ ; sporophoris non-visis; sporae ellipsoideae vel fusioideae, hyalinae, unicellulares, rectae, ad utrumque apicem obtusae, 4.8–6.7  $\times$  1.4–1.9  $\mu$ , bi-guttulatae, emergentes in massa gelatinosa post-dehiscunt et in cirrhis per ostiolum.

In foliis viventibus *Achyranthidis asperae* L. e familia Amaranthacearum, Kanpur (U.P.), India, mense augusto 1963, L. S. Chauhan et S. C. Verma; Typus positus in Herb. Crypt. India Orient., I.A.R.I., New Delhi, et in Herbario Commonwealth Mycological Institute, Kew, in Anglia subnumero I.M.I. 103831.

A culture of the fungus was isolated on 2% potato-dextrose agar and its pathogenicity was proved according to the Koch's postulates. Further work on the physiology of the fungus and its control measures is in progress.

Thanks are due to Dr. J. C. F. Hopkins and Mr. Sutton of the C.M.I., Kew, Surrey, England for confirming the identification and to Dr. H. Santapau, Director, Botanical Survey of India, Calcutta, for the Latin diagnosis of the new species.

Section of the Plant Pathologist R. S. MATHUR.  
to Govt. of Uttar Pradesh, L. S. CHAUHAN.  
Kanpur, March 23, 1964. S. C. VERMA.

#### EXORMOTHECA CEYLONENSIS MEIJER—NEW TO INDIAN FLORA

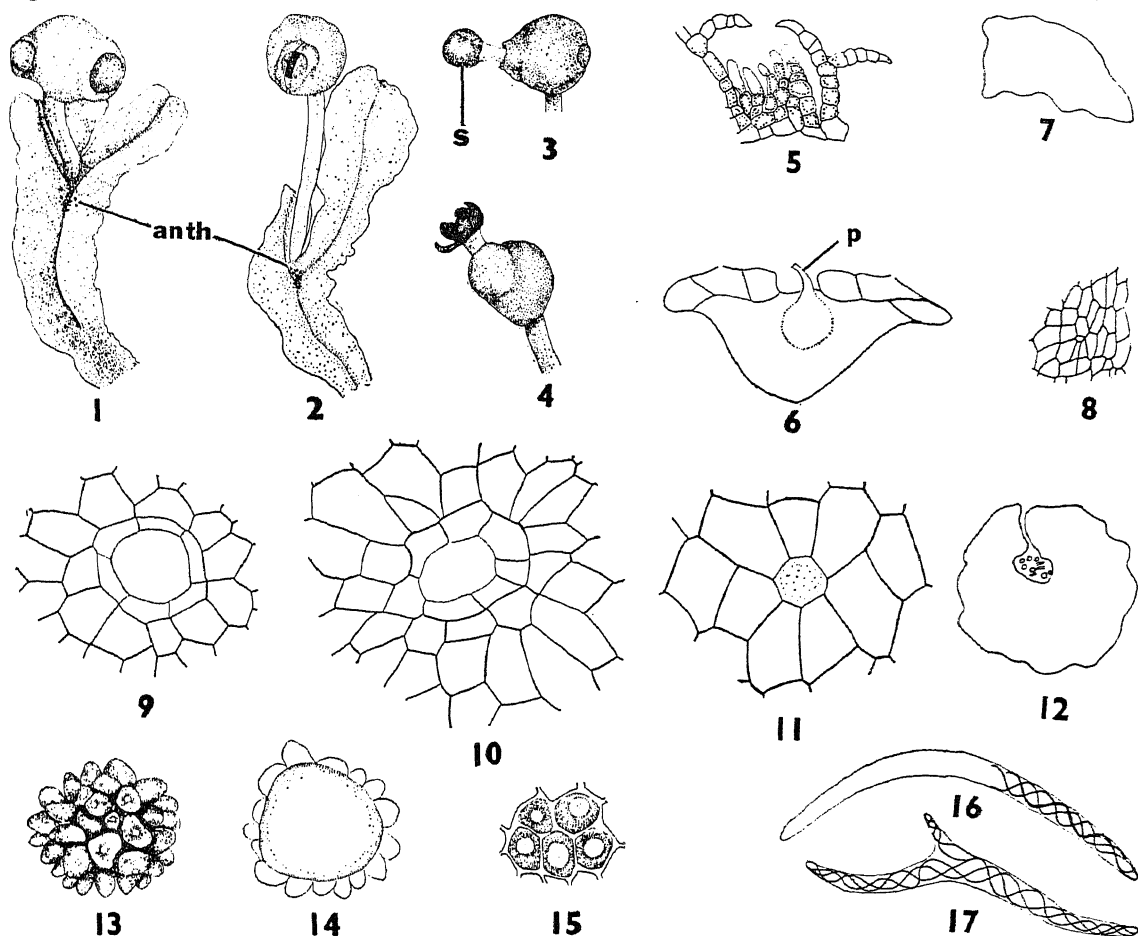
THE liverworts from South India are very inadequately known and their comparison from those described by Kashyap (1929) from the Western Himalayas have in many cases resulted in erroneous identifications. An effort is therefore being made to publish accounts of the South Indian liverworts with the view to fill this gap in the knowledge of Indian bryology. The present paper describes the details of *Exormotheca ceylonensis* an interesting addition to the liverwort flora of India.

So far the genus *Exormotheca* Mitten is known in Indian flora by a single species *E. tuberifera* Kashyap originally described from Mussoorie (Kashyap, 1914). The other species *E. gollani* St. (Stephani, 1917) described from Simla in Western Himalayas was treated by Kashyap (1929) as a synonym of *E. tuberifera* who listed Madras, South India, as a new locality for this plant.

During October-November 1962 we made extensive collections of bryophytes from a number of places in South India which includes an *Exormotheca* from Kodaikanal bus route which presents many features of interest and is closely related to *E. ceylonensis* Meijer recently described from Kadagannawa (1,500 ft.) from Ceylon (Meijer, 1956). The plants grow on extensive mats on soil on exposed rocks and are particularly abundant at lower altitudes between 1,500 ft. and 3,000 ft. often reaching higher limits.

devoid of them (Meijer, 1956). However, the South Indian plants often show their apex somewhat thickened although definite stalked tubers were never noticed in a very large population examined.

The thalli are 1-2 times dichotomously branched with the dorsal surface showing a thin mid-dorsal streak and polygonal areas (Fig. 1). Quite often one branch is considerably suppressed (Fig. 2). The epidermal pores (Fig. 9) on the thallus are simple with a ring of 6-8 cells surrounding them. The air chambers (Fig. 6)



FIGS. 1-17. *Exormotheca ceylonensis* Meijer. Fig. 1. Plant with female receptacle and antheridia—*anth.*,  $\times 5$ . Fig. 2. Plant with a suppressed thallus lobe,  $\times 5$ . Fig. 3. Female receptacle with mature capsule—*S*,  $\times 5$ . Fig. 4. Dehiscing capsule,  $\times 5$ . Fig. 5. Air chamber with assimilatory filaments in T.S.,  $\times 200$ . Fig. 6. T.S. of thallus, *p*—papilla of antheridial chamber,  $\times 16$ . Fig. 7. Ventral scale,  $\times 30$ . Fig. 8. Cells of the scale,  $\times 100$ . Fig. 9. Epidermal pore,  $\times 100$ . Figs. 10-11. Normal pore and simple pore of the receptacle,  $\times 190$ . Fig. 12. T.S. stalk,  $\times 50$ . Fig. 13. Spore from spherical face,  $\times 300$ . Fig. 14. Spore from inner face,  $\times 300$ . Fig. 15. Magnified hollow papillae on outer face of spore,  $\times 400$ . Figs. 16-17. Elaters,  $\times 300$ .

In contrast to *E. tuberifera* which is characterized by the presence of numerous tubers (Kashyap, 1914) the thalli of *E. ceylonensis* are

occur in a single row in about 1/5 of the total thallus thickness containing simple assimilatory filaments each with a row of 3-5 cells (Fig. 5).

The terminal cell is somewhat longer with lesser number of chloroplasts as compared to cells below. The midrib is prominent and the wings abruptly attenuate. The ventral scales are simple, unappendaged (Figs. 7, 8) and in two rows. The antheridia (Figs. 1-2, *anth.*) occur very close behind the female receptacle and are embedded in the thallus along the mid-dorsal line in 2-3 rows. The ostioles are prominent (Fig. 6, p.).

The female receptacle is terminal at the point of dichotomy (Figs. 1-2) and has 1 (-2) involucre. The two lobes (often one) of the thallus continue to grow after the formation of the female receptacle and bifurcate again. A young female receptacle develops at the point of fresh dichotomy at each end. The stalk of the female receptacle is smooth with wavy margin and has one deep rhizoid furrow (Fig. 12). The pores on the receptacle are of two types: simple and undifferentiated having no pore opening (Fig. 11) as in *E. ceylonensis* and normal (Fig. 10) as in *E. tuberifera*. However, we have examined specimens of *Exormothea* from Kandy, Ceylon, from a collection made by the late Prof. S. K. Pande in 1938 and in this gathering both the types of pores are present exactly as in the South Indian plants. It appears that Meijer (1956) somehow failed to observe the normal pores in his specimens. Below the outer layer are low assimilatory filaments in a row as on the thallus.

The sporophyte has a nearly spherical capsule (Fig. 3), a short seta (up to 1.5 mm. long) and a short foot. The capsule wall has a single row of cells with the inner walls having brown semi-annular thickening bands and it dehisces by 4-5 irregular valves (Fig. 4). The spores are 75-85  $\mu$  in diameter with a size range larger than *E. tuberifera* (55-60  $\mu$ ) and close to *E. ceylonensis* (80-90  $\mu$ ). The convex outer face has light brown hollow elevations up to 20 in profile (Figs. 13-15). The bases of these elevations indicate 3-5 reticulations across spore diameter. The elaters are simple (Fig. 16), often branched (Fig. 17) and with 3-4 spiral thickening bands.

Department of Botany, RAM UDAR.  
University of Lucknow, VINOD CHANDRA.  
Lucknow, India, March 19, 1964.

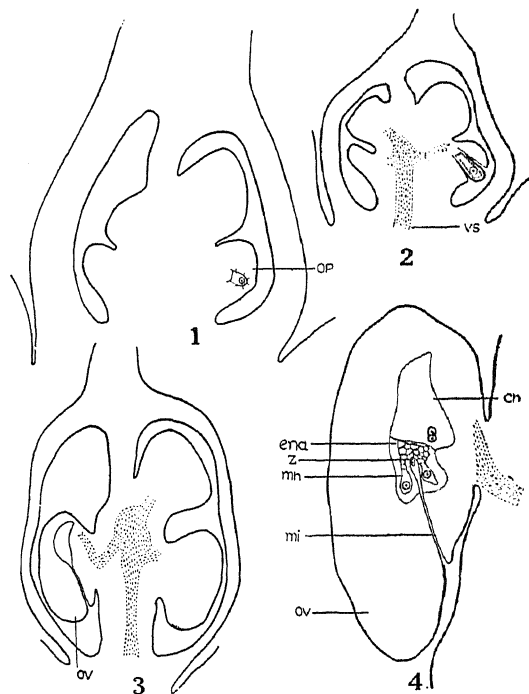
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### OVULE IN PLANTAGO

SCHNARF (1917, 1929, 1931) and Cooper (1942) mention the ovule in *Plantago* as anatropous while Lubbock (1892) describes it as amphitropous. The present author, while making a detailed study of the embryology and seed structure of six species of *Plantago*, observed that the ovule in none of these species is either anatropous or amphitropous as described by these authors (Misra, 1963).

The ovular primordium arises as a lateral dome-shaped body on the axile placenta of a bicarpellary pistil. The archesporial cell is differentiated early (Fig. 1) while the differentiation of the nucellus and integument takes place at the megaspore mother cell stage (Fig. 2). The ovule at this stage shows greater



FIGS. 1-4. *Plantago major*. Figs. 1-2. L.s. ovary showing ovule before and after the differentiation of nucellus and integument respectively,  $\times 60$  and  $\times 47-62$ . Fig. 3. Same showing the vascular supply to the ovule. Note the slightly curved embryo-sac,  $\times 47-62$ . Fig. 4. L.s. ana-campylotropous ovule whose micropyle faces the placenta. Note the chalazal and vascular supply to it being confined to placenta,  $\times 47-62$ . (*ch*, chalazal haustorium, *end*, endosperm; *mi*, micropylar hasurtorium; *mi*, micropyle; *op*, ovular primordium; *ov*, ovule; *vs*, vascular supply; *z*, zygote.)

growth on its abaxial side on account of which it assumes anatropous form and its vascular supply is found to have reached the chalaza (Fig. 3). Henceforth the ovule shows two definite regions of growth, one at the micropylar and the other at the chalazal regions of the dorsal half of the integument. On account of this the chalaza along with the vascular supply and the micropyle are both pushed towards the placenta. At maturity (Fig. 4) the chalaza as well as the vascular supply to the ovule come very close to the placenta and as the micropyle faces the placenta the embryo-sac gets slightly curved without any sign of a basal body. Thus the ovule falls under ana-campylotropous form of Bocquet (1959).

The author is grateful to Dr. Bahadur Singh and Dr. S. P. Bhatnagar for guidance and to Prof. K. N. Kaul, Director, for facilities and encouragement. Thanks are also due to C.S.I.R. for award of a Junior Research Fellowship.

National Botanic Gardens,  
Lucknow, March 10, 1964.  
RAMESH CHANDRA MISRA.

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## A NEW SPECIES OF *CERCOSPORA* ON AN ECONOMIC HOST

In the course of his survey for new fungi in and around Poona the writer collected leaves of *Osyris arborea* Wall. (Santalaceae) infected with dark brown spots. Sections through the infection spots revealed the presence of a hyphomycetous scolecosporic fungus, characterised by the formation of short conidiophores arising in fascicles over a prominent stroma and ascicular olive-coloured septate conidia typical of the genus *Cercospora*.

As there is no previous report of a *Cercospora* on this host nor on the family Santalaceae, a detailed comparison was made between this *ranunculi* Ell. and Holw. with the results given in Table I.

The Poona species is characterised by extremely short conidiophores and much smaller conidia besides being collected on a

hitherto unreported host, on the basis of which it is presented as a new species with Latin diagnosis.

TABLE I

Species	Conidiophores	Conidia	Authority
<i>Cercospora ranunculi</i>	70-90 × 3-4 $\mu$	70-85 × 3-4 $\mu$	Saccardo IV 1886 (I)
<i>Cercospora</i> sp.	14-30 × 4.3-5 $\mu$	27.5-70.5 × 4.3-5 $\mu$	..

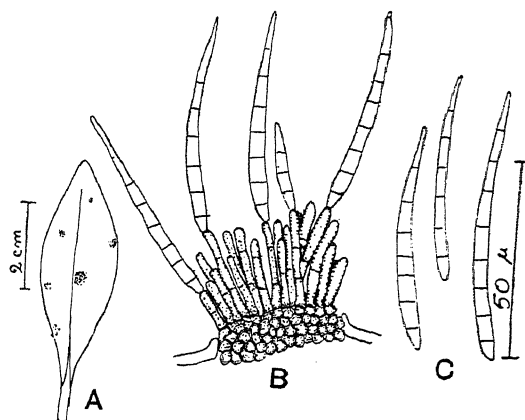


FIG. 1. A. Habit, B. Fruiting body, C. Conidia.

*Cercospora santalacea* GOPINATHAN  
NAIR, K. R. SP. NOV.

Infectionis maculae amphigenae, sordide brunneae, circulares, dispersae, ad 5 mm. plures in singulis foliis. Fructificationes vulgo hyphophyllae, non-numquam amphigenae, emergentes laxe fasciculatae per rupturam epidermidis, stromate bene evoluto et compacto ad basin, alte brunneae.

Conidiophora simplicia breviter brunnea laxè aggregata divergentia plura in singulis-fasciculis, cicatrice ad apicem, 1-2 septata, 14-30 × 4.3-5  $\mu$ . Conidia pallide olivacea longe cylindrica vel filiformia, cicatrice ad basin, 3-8 septata, 27.5-70.5 × 4.3-5  $\mu$ .

Incitat maculas in foliis *Osyris arboreae* Wall. e familia Santalacearum. Leg. Gopinathan Nair, K. R. ad Poona in India mense agosto, 1963, M.A.C.S. No. 173 (Type).

Thanks are due to Prof. M. N. Kamat for his guidance and to Dr. H. Santapau for Latin diagnosis.

M.A.C.S. Laboratory, K. R. GOPINATHAN NAIR.  
Poona-4, March 13, 1964.

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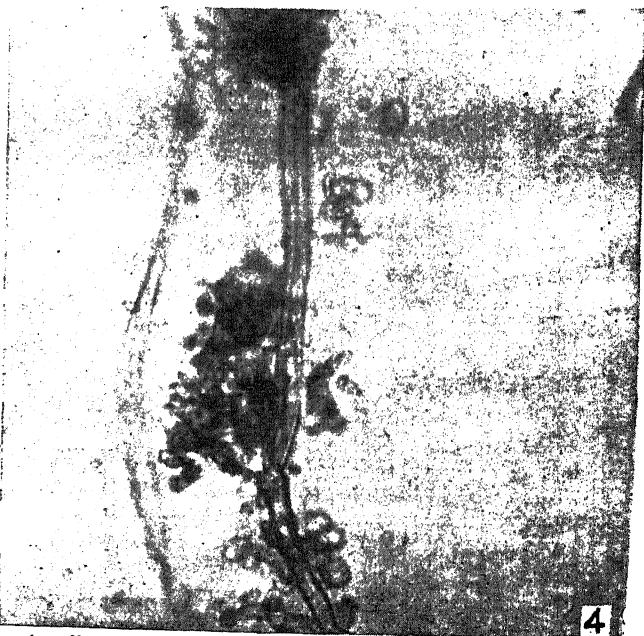
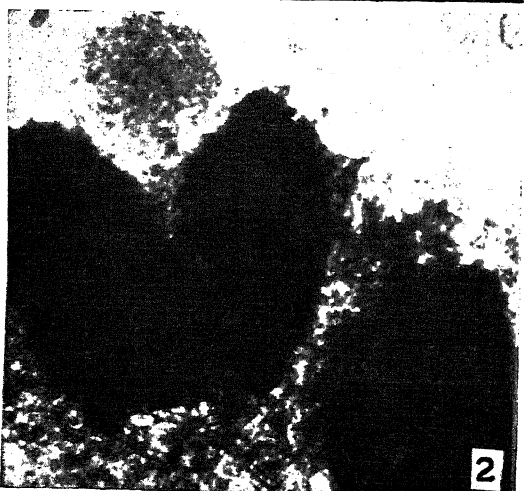
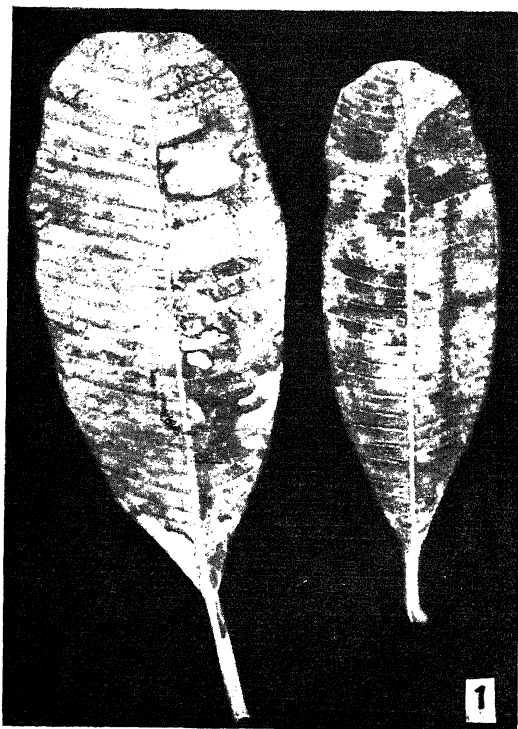
## THREE FUNGI NEW TO INDIA

THE fungi reported in this note were isolated by the author from his mycological collections of leaf-spot diseases of Allahabad and adjacent regions. They are being described here as new records from India.

1. *Phyllosticta plumieræ* F. Tassi in *Bull. Lab. Ort. Bot. Siena*, 1901, IV, p. 8; Saccardo, *Syll. Fung.*, 1906, 18, 292.

On leaves of *Plumeria alba* L. Alfred Park, August 1963, Leg. S. Chandra. (IMI—103798).

The disease starts as small pale smoke-gray spots on the upper surface at any part of the leaf. As the spots increase in size their colour changes to pale drab-gray or drab-gray. At maturity the spots assume any form (Fig. 1). Generally a single spot covers an appreciable area of the leaf including a portion of midrib or margin of



FIGS. 1-4. Fig. 1. Diseased leaves of *Plumeria alba*. Fig. 2. Pycnidia and conidia of *Phyllosticta plumieræ*. Fig. 3. Conidiophore and hülle cells of *Aspergillus quadriliniatus*. Fig. 4. Conidiophore of *Cladosporium sphaerosphaerum*.

the lamina. Rarely a number of small spots are seen on a single leaf. The coalescence of spots is very occasional. Careful observation of the mature spots reveals the presence of extremely minute black pycnidia on the upper surface. They appear to be embedded in the leaf tissue.

Pycnidia lens-shaped, embedded with protuberance outside, black,  $156-168\ \mu$  in diameter, texture of wall pale, wall membranous, conidia hyaline, elliptical,  $2-2.5 \times 4-4.5\ \mu$  (Fig. 2).

2. *Cladosporium spherospermum* Penz., *Fung. Agrum. in Mich.* II, p. 473 et *F. ital.* t: 1203, Saccardo, *Syll. Fung.* 1886, 4, 355.

Growing saprophytically on dead leaves of *Pisum sativum* L., Chowk Market, January 1963, Leg. S. Chandra (IMI-102304).

Erect or creeping, branched and septate hyphae on the surface as well as inside the substrate, brown in colour; conidiophores erect, branched, septate, frequently aggregated together, forming a velvety layer, brown in colour,  $140-310\ \mu$  long and  $3.5-4.5\ \mu$  broad; conidia borne at tip or laterally near tip (Fig. 4), arising in chains, round or oval in shape, rarely uniseptate, size variable, smaller ones  $3-3.4 \times 4-4.5\ \mu$ , bigger ones  $6.5-14 \times 3.5-4.5\ \mu$ , hyaline or olive-coloured, smooth-walled.

*Cladosporium spherospermum* has been reported by a number of workers on a variety of substrates from other parts of the world. Rothwell (1958)<sup>1</sup> isolated it from oil paint films exposed on test fences at U.S.A. Kramer *et al.* (1959)<sup>2</sup> isolated a number of species of *Cladosporium* including the present one from air at Manhattan.

3. *Aspergillus quadrilineatus* Thom and Raper (A *Manual of Aspergilli*, Williams and Wilkins Co., Baltimore, p. 373).

Growing saprophytically on dead leaves of *Allium cepa* L., Chowk Market, January 1963, Leg. S. Chandra (IMI-102312).

On Czapek's agar it grows in form of spreading and plane colonies, each colony has a outer olive green conidial region towards the margin and a central purplish-gray region, colour of reverse side purplish-red.

Cleistothecia light brownish, spherical, covered by hülle cells,  $120-155\ \mu$  in diameter (hülle cell layer included), cleistothecial wall one cell layer thick; ascospores purple red in colour, lenticular in shape, smooth-walled, each with two plaited equatorial crests ( $0.5\ \mu$  in width),  $4.5 \times 3.5-3.7\ \mu$  in size; conidial heads columnar (Fig. 3), short, green,  $60-75 \times 30-35\ \mu$  in size; stalk dull brown, sinuate, wall smooth, length  $50-70\ \mu$  and width  $3.5-4.5\ \mu$  but

$7.5-9\ \mu$  at the hemispherical vesicle; phialides in two series, primary phialides  $5-6 \times 2-3\ \mu$ , secondary phialides  $5-7 \times 2-2.5\ \mu$ ; conidia pale yellow green, globose, rugulose,  $3-4\ \mu$  in diameter.

This species of *Aspergillus* has been isolated by a number of workers from different countries of the world. Thom and Raper (1939)<sup>3</sup> reported it from a number of places in United States including Texas, New Jersey, Maryland and Louisiana.

The author wishes to thank the Director, Dr. Ellis and Mr. Elphick of the Commonwealth Mycological Institute, Kew, for the help in the identification of the species. The help given by Mr. M. P. Srivastava is gratefully acknowledged.

Botany Department, SUDHIR CHANDRA.  
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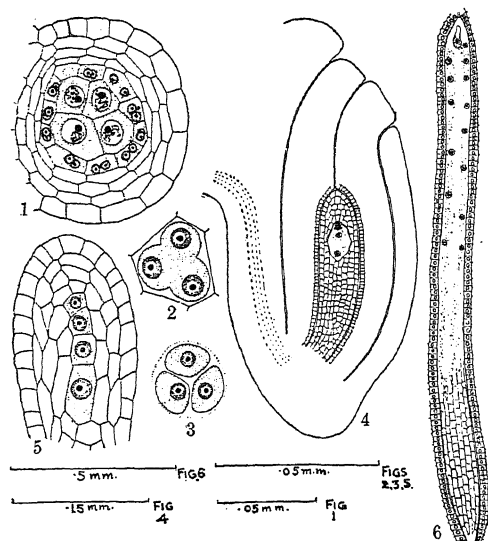
## EMBRYOLOGY OF A FEW SPECIES OF *ERYTHROXYLUM*

THE early embryological work in the family Erythroxylaceae was reviewed by Schnarf (1931). Subsequently, Mauritzon (1934) studied the embryology of *Erythroxylum coca*. Recently, Narayana (1960) studied the floral anatomy of *E. coca*, *E. monogynum* and *E. mooni* and the development of male and female gametophytes in the two latter species. The present paper deals with the embryology of five species of *Erythroxylum*, viz., *E. lanceum* Bojer., *E. cuneatum* (Miq) Kurz., *E. ecarinatum* Burck., *E. mooni* Hochr. and *E. monogynum* Roxb.

The flower is regular, bisexual and pentamerous. The petals bear appendages on the inner side. The ten stamens are basally connate. The gynoecium is tricarpellary and of the three carpels only one is fertile and bears a single ovule, which receives two traces, a feature recorded earlier by Narayana (1960).

The anther shows an epidermis and 3-4 wall layers, of which, the innermost functions as the secretory tapetum (Fig. 1). The cells of the tapetum are uninucleate in early stages and ultimately become bi-nucleate (Fig. 1). The fibrous endothecium develops from the hypodermal wall layer. The divisions of the pollen mother are simultaneous and cytokinesis takes place by cleavage furrowing (Fig. 2).

Pollen tetrads are tetrahedral (Fig. 3). Pollen is shed at the three-celled stage.



FIGS. 1-6. Fig. 1. *E. ecarinatum*. T.S. anther lobe showing the sporogenous tissue, tapetum and wall layers. Figs. 2-3. *E. cuneatum*. (Fig. 2. P.M.C. showing cytokinesis, Fig. 3. Pollen tetrad). Figs. 4-5. *E. lanceum*. (Fig. 4. Ovule in L.S.; Fig. 5. L.S. nucellus showing the megaspore tetrad and parietal layers. Fig. 6. *E. moonii*. Embryo sac showing the zygote and endosperm nuclei.)

The ovule is crassinucellar, bitegmal and anatropous (Fig. 4). The nucellus is long and narrow. The micropyle is formed by the inner integument alone. The parietal tissue is 3-5-layered. The innermost layer of the inner integument forms the endothelium, the cells of which are uninucleate (Fig. 6). As in the other investigated species of the genus, the obturator is absent.

The archesporium in the ovule is single-celled and hypodermal. The archesporial cell functions as the megaspore mother cell after cutting off a primary parietal cell, which gives rise to 3-5 parietal layers (Fig. 5). The megaspore mother cell as a result of meiosis gives rise to a tetrad of megaspores. Only linear megaspore tetrads are observed (Fig. 5). The embryo-sac develops according to the *Polygonum* type and shows the usual organization. The antipodals are ephemeral and the polar nuclei fuse before fertilization. During development the embryo-sac enlarges crushing the nucellar epidermis and the parietal layers on the sides and above and some of the nucellar cells below. A strand of nucellar tissue persists even after fertilization (Fig. 6).

Fertilization is porogamous.

The primary endosperm nucleus divides to form a number of free endosperm nuclei before the zygote undergoes the first division (Fig. 6). While the endosperm in the micropylar region becomes cellular by about the time the embryo attains the globular stage, it remains nuclear in the chalazal region. Ultimately, it becomes cellular in this region also. Although a portion of the endosperm is used up by the developing embryo, it persists as a tissue in the mature seed. The cells are packed with starch grains.

The embryo develops according to the *Solanad* type of Johansen (1950).

The fruit is a drupe containing a single seed. The seedcoat consists of a layer of thick-walled cells and develops from the outermost layer of the inner integument. The seed is endospermic.

My thanks are due to Prof. M. R. Suxena for his keen interest, and to Dr. Anwari Dilmy for the materials of *E. lanceum*, *E. cuneatum* and *E. ecarinatum*.

Department of Botany, L. L. NARAYANA.  
Osmania University,  
Hyderabad-7 (A.P.), March 12, 1964.

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## A NEW FUNGUS ON PANDANUS FROM ASSAM

DURING the routine collection work, a species of *Haplosporella sensu* Petrak et Sydow (1926), hitherto unrecorded, was observed by the author on *Pandanus minor* P. Henn. from Borbhetta, Assam. Spots, large straw-coloured with rounded ends of variable size up to 20 cm. long and 1.5-3 cm. broad, appear along the length of the leaves bordered by brownish margin which later on become completely blighted. The epidermis, at this stage, is separated from the tissues with the black, stromatic pycnidia formed underneath. The following is the formal description of the new species.

*Haplosporella pandanicola* A. K. ROY, SPEC. NOV.

Maculae ut plurimum in superiore pagina foliorum. Stromata primo immersa, tum erumpentia, globosa vel oblonga vel urceolata fusce brunnea, 364-500  $\times$  285-385  $\mu$  diam. Pycnidia globosa vel elliptica, 150-221  $\times$  107-264  $\mu$  diam. Conidiophora obsoleta. Pycnidiosporae subhyalinae, postea dilute brunneae, parietibus crassis, ellipticae vel obclavatae, 20-31  $\times$  10-16  $\mu$ , contentis granularibus.



Typus lectus in *Panduo minore* P. Heen. a  
A. K. Roy die 21 junii anni 1963 ad Borbheta

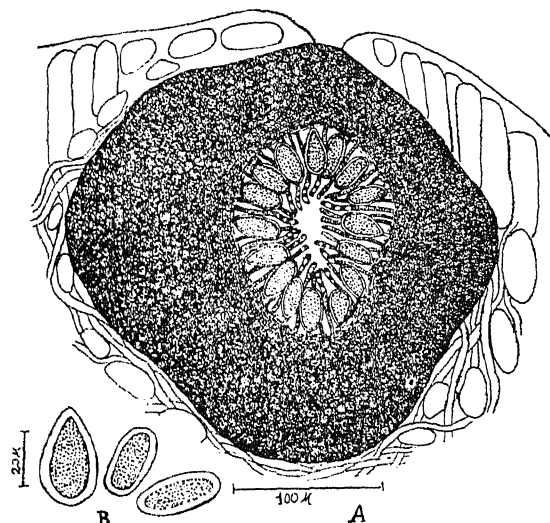


FIG. 1. *Haplosporella pandanicoila* spe. nov. A—C.S. of pycnidium; B—spores.

in Assamia, et positus in herbario cryptogamico  
Indiæ orientalis, ad New Delhi, sub numero  
28231.

Spots mostly on the upper surface of leaves,  
Stroma immersed first, later becoming erumpent,

globose to oblong or flask-shaped, dark brown,  
364–500 × 285–385 µ in diameter, pycnidia  
globose to elliptic, 150–221 × 107–264 µ in  
diameter. Conidiophores obsolete, pycnidiospores  
subhyaline, later dilute brown, thick-walled,  
elliptic to obclavate; 20–31 × 10–16 µ, with  
granular contents.

Type specimen on *Pandanus minor* P. Henr.,  
Collected by A. K. Roy, 21-6-1963, Borbheta,  
Assam, deposited in the Herbarium Cryptogamicum  
Indiæ Orientalis, New Delhi, Accession No. 28231.

My thanks are due to Dr. V. Agnihotrudi,  
Tocklai Experimental Station, Cinnamara,  
Assam, for his help during the course of the  
studies and to Rev. Fr. Dr. H. Santapau for  
rendering the Latin diagnosis.

Division of Mycology,  
Department of Agriculture,  
Assam, Jorhat, March 11, 1964.

A. K. Roy.\*

\* Mycologist to the Govt. of Assam, Jorhat.

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## NEW HYPOTHESIS ON EARLIEST MAN

TWO developments in recent months appear to have pushed far back in time the eras of the first men and their forebears. The British paleontologist L. S. B. Leakey has discovered in Africa the bones of creatures he regards as the earliest men, for whom he has proposed the name *Homo habilis*. E. L. Simons of Yale University has proposed a classification of premen that "increases tenfold the approximate time period during which human origin can now be traced with some confidence".

Previously the first true man had been thought to be *Pithecanthropus*, a creature that lived about 500,000 years ago. The bones Leakey *et al.* have found in Africa appear to date as far back as 1.8 million years. Leakey describes the creatures as walking erect on feet almost identical with modern man's and as having hands of considerable dexterity. Incidentally it may be mentioned that Leakey has abandoned his earlier opinion that *Zinjathropus*, a man-like creature whose bones he found in Africa in 1959, was on the line of evolution to man. According to him a more recent find of a specimen about

200,000 years younger indicates that *Zinjathropus* did not continue evolving toward man.

Simon's proposal relates to the transition from the dryapithecine apes of the Miocene-Pliocene epochs (25 million to 2 million years ago) to the first hominids, or man-like creatures, of the early Pleistocene, which was the epoch following the Pliocene. According to Simon several fossil bones previously classified under such names as *Bramapithecus* and *Kenyapithecus* belong to the genus *Ramapithecus*. Since some of the bones have been dated by several methods as being 14 m. years to 15 m. years old, *Ramapithecus* dates back to the Miocene epoch. "Since *Ramapithecus* is unlike the apes in dentition and since it foreshadows in known parts the structure of the same parts in Pliocene relations of man, it is logical to conclude that *Ramapithecus* is on, or near, our ancestral line. The exciting thing about this proposal is that we have now a forerunner of man nearly ten times as old as the earliest undoubted relative of man."—(*Scientific American*, May 1964.)

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## REVIEWS

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**Geophysics—The Earth's Environment.** Edited by C. Dewitt, J. Hieblot and A. Lebeau. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York and London), 1963. Pp. 1-624.

The 1962 session of the Les Houches Summer School of Theoretical Physics held in the French Alps was devoted to the physics of the earth's environment. The volume contains essentially the material of the lecture courses given during the session by a distinguished faculty of internationally recognized specialists. The basic theories in geophysics (plasma physics, magnetoionic theory, Störmerian particles, collective motion) are discussed in the opening chapters. Part II of the volume provides general descriptions of the composition, ionization and luminous emissions of the terrestrial atmosphere extended to the boundaries of interplanetary space. The closing chapters consider disturbances of solar origin, various waves and their interaction with the earth environment. Advancing quickly but comprehensively from basic principles to specialized questions, and surveying much of recent geophysical progress since the advent of research rockets and satellites, the lectures synthesize present knowledge of the subject from fundamental themes to the frontiers of theoretical research.

Among the longer and more comprehensive memoirs included in the second part of the volume are those by Marcel Nicolet on the constitution and composition of the upper air, by D. Barbier on the atmospheric luminescence and the polar aurora, and by Sydney Chapman on solar plasma, geomagnetism and the aurora. Other contributors are J. F. Denisse, K. G. Budden, J. W. Chamberlain, R. Benoit, G. J. F. Macdonald, J. W. Dungey and R. Gallet.

C. V. R.

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**Dover Republications of the Classics of Science**  
**Treatise on Light.** By Christian Huygens.  
Pp. 129. Price \$ 1.35.

This publication is a reprint of a well-known classic. Christiaan Huygens, 1629-95, Dutch Mathematician, Astronomer and Physicist, was one of the greatest scientists of his time and the present volume is the celebrated essay in which he has enunciated the wave-theory of light and presented the experimentation sup-

porting it. The book is an unabridged, unaltered republication of the well-known translation by Silvanus P. Thompson. Even at the present time Huygens' book will be found to be of deep interest by students of optics.

**Electric Waves.** By Heinrich Hertz. (Translated by D. E. Jones, with Preface by Lord Kelvin). Pp. 278. Price \$ 1.75.

Heinrich Hertz (1857-94), protege of Hermann von Helmholtz, was one of the most brilliant figures in 19th century scientific research. The experimental discoverer of electromagnetic waves, he contributed significantly to the development of modern physical theory, and laid the groundwork (together with Faraday, Maxwell, and others) for the development of radio, telephone, telegraph, television, and other modern technical marvels.

His book can now be regarded as a classic in its field. The book brings together various papers in which Hertz described the theoretical steps and experiments by which he probed the existence of electromagnetic waves and showed experimentally that their velocity equalled that of light. Its value to the modern reader is largely historical, but fundamental research men in the expanding field of electromagnetic theory will still find Hertz's thoughts pregnant with significance. And of course there is the inestimable profit in following the workings of an extraordinary intellect, one which Helmholtz himself considered "capable of the greatest acuteness and clearness in logical thought".

C. V. R.

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**Origin of the Solar System.** Edited by R. Jastrow and A. G. W. Cameron. (Academic Press, New York and London), 1963. Pp. 176. Price \$ 8.00.

Origin of the solar system is an age-old problem that had attracted the attention of great master-minds like Descartes, Kant, Buffon, Laplace in the past, and more recently Jeans, Jeffries and others. Many theories have been proposed from time to time but none completely satisfactory. There are two general schools of thought. One holds that a catastrophe occurred on a stellar scale in which the planets were formed as a by-product. A near collision of two stars (one of which was the sun) may have

led to the ejection of a filament of gas from the sun, from which condensation into planetary bodies subsequently occurred. The other school favours the nebular hypothesis which suggests that planets were created as minor condensations in the process of gravitational contraction which led to the formation of the primitive sun out of the gas and dust of interstellar space. As the protosun contracts it must spin faster in order to conserve the angular momentum and must shed mass in an equatorial plane, thus leaving behind a nebular disk, and further process of condensation of the matter of the disk was responsible for the formation of the planets.

Naturally, all past approaches about the origin of the solar system have been more or less qualitative, discussing possible processes that might lead to our planetary system. No theory was strictly quantitative in all respects. Current thinking is that cosmogony also can, and should, be treated by the same rigorous analytical methods that have been so successful in other branches of astrophysics. This is becoming increasingly possible now because our quantitative information about the solar system and its early history is also rapidly increasing; to quote only two sources we have, (1) the new science of meteorites, and (2) the exploration of the moon and the near planets regarding precise information about their surfaces and atmospheres.

The results of some current thinking on problems connected with the origin of solar system are brought together in this handy publication which contains the proceedings of the Conference on the subject, held in New York in January 23-24, 1962, at the Goddard Institute for Space Studies.

A. S. G.

#### Radiation Chemistry of Polymeric Systems.

Edited by Adolphe Chapiro. (Interscience Publishers, New York), 1962. Pp. 712. Price \$21.00.

The present large-scale development and interest in radiation initiated polymerization started soon after the World War II when it became apparent that powerful radiation sources will be available for research purposes. A large number of papers from research groups in this field all over the world have appeared in different journals. It is gratifying to note that a voluminous amount of scattered data in this field has been adequately compiled in one publication and the author has presented a logical account and interpretation of the experimental

data and even revised his manuscript in the light of further conclusions reached during the 3-year period of his writing this volume. The book primarily addressed to polymer chemists has a few chapters exclusively dealing with radiation chemical aspects which should serve as a useful background.

The book is 15th volume of the well-known 'High Polymer' series brought out by Interscience Publishers. It is divided into 5 major parts spread over 12 chapters. The large number of references to recent original papers, at the end of each chapter, make it a valuable reference book.

The first chapter lists sources of radiation and gives definitions of various terms and units commonly employed in a radiation laboratory. Physical and chemical changes accompanying irradiation of simple molecules are described in Chapter II. For a better understanding of the effects of irradiation on polymers, Chapter III presents necessary background by describing irradiation of simple aliphatic and aromatic compounds and mechanisms involved therein. The next four chapters are devoted to kinetics of radiation initiated polymerization reactions as being free radical mechanisms, homogeneous polymerization of monomers like styrene, methyl methacrylate, methyl acrylate, vinyl acetate; heterogeneous polymerization of vinyl chloride, acrylonitrile where liquid monomers act as precipitants to the polymers formed; polymerization of gaseous and solid monomers and polymerization in presence of added substances, e.g., polymerization in solution or in a precipitating media, suspension and emulsion polymerization. The physical and chemical changes accompanying cross-linking or degradation of solid polymers together with the possible mechanisms involved and the great practical importance of such reactions are discussed in Chapter X. Experimental results on the radiolysis of solutions of common polymers, which serve as model for investigation radiation effects in biological systems, are dealt with in the following chapter. The various techniques and conditions that determine the extent and chain length in the process of grafting are discussed in the last chapter, together with experimental data in case of polyethylene. The effects of temperature, dose, rate of irradiation on grafting are also discussed and some experimental data in the grafting of polyisobutylene, polymethyl methacrylate, polyvinyl chloride, polyamides and other polymers, without discussing their practical applications, are also presented.

It should be a useful addition to the libraries of institutions engaged in research on polymers. It is further hoped that a book like this will help to stimulate interest in the subject, which after receiving a notable attention seems to be presently somewhat neglected.

S. L. KAPUR.

**The Cell in Mitosis.** Edited by Laurence Levine. (Academic Press, New York and London), 1963. Pp. 274. Price \$10.00.

The basic mechanisms responsible for the regularity in the behaviour of the chromosomes during cell division remain still enigmatic. The volume under review is a record of the proceedings of a symposium where students on different disciplines have explored the problem of mitosis. The attempt to make the atmosphere informal and thus favour free discussion appears to have been successful as the following quotation would indicate. "The idea that histones play a role in somatic heredity has served as a motivating hypothesis for some years. The role of histones may ultimately be shown to be trivial, and our introduction inappropriate. No matter—in the meanwhile we shall have had the fun of relating the work to an exciting biological problem, and at present the likelihood of such a gross error seems remote indeed" (p. 205). The approaches to problems and the method of presentation are interesting.

M. K. S.

**Cinemicrography in Cell Biology.** Edited by George G. Rose. (Academic Press, New York and London), 1963. Pp. 500. Price \$18.50.

In the 1930's W. H. Lewis introduced cinematography for the study of pinocytosis. The brilliant work carried out by him with its aid stimulated the interest of other investigators. Time lapse cinematography using the phase contrast microscope made cellular analyses exciting. Demonstration of its utility for teaching as well as research initiated its rapid advance to its present stature.

This volume makes available for the first time the data on apparatus, technique and methods used in the analysis of some problems in laboratories in Europe and America. The information presented is valuable.

M. K. S.

## Books Received

From: (Academic Press, Inc., 111 Fifth Avenue, New York-3, N.Y.):

*Progress in Astronautics and Aeronautics* (Vol. 12)—*Ionization in High Temperature Gases*. Edited by K. E. Shuler and J. B. Fenn, 1964. Pp. xiv + 409. Price \$5.75.

*Advances in Food Research* (Vol. 12). Edited by C. O. Chichester, E. M. Mrak and G. F. Stewart, 1964. Pp. ix + 433. Price \$14.00.

*The Formation of Wood in Forest Trees*. Edited by M. H. Zimmermann, 1964. Pp. xv + 562. Price \$16.00.

*Theory of Exciton* (*Solid State Physics, Supplement No. 5*). By R. S. Knox, 1964. Pp. vii + 207. Price \$8.50.

*The Monosaccharides*. By J. Stanek, M. Cerny, J. Kocovrek and J. Pacak, 1963. Pp. 106. Price \$32.00.

*International Review of Experimental Pathology* (Vol. 2). Edited by G. W. Richter and M. A. Epstein, 1963. Pp. xiii + 446. Price \$16.00.

*Advances in Electronics and Electron Physics* (Vol. 19). Edited by L. Marton, 1964. Pp. x + 323. Price \$12.00.

*A Photographic Atlas of Shark Anatomy—The Gross Morphology of Squalus Acanthias*. By C. Gans and T. S. Parsons, 1964. Pp. 106. Price \$3.95.

*Advances in Child Development and Behaviour* (Vol. 1). By L. P. Lipsitt and C. C. Spiker, 1963. Pp. xiii + 387. Price \$12.00.

*X-Ray Optics and X-Ray Microanalysis*. Edited by H. H. Pattee, V. E. Cosslett and A. Engstrom, 1963. Pp. xvii + 622. Price \$22.00.

*Advances in Metabolic Disorders* (Vol. 1). Edited by R. Levine and R. Luft, 1964. Pp. xii + 366. Price 86 sh.

*Cellular Membranes in Development*. Edited by M. Locke, 1964. Pp. xvi + 382. Price \$12.00.

*Advances in Space Science and Technology* (Vol. 5). Edited by F. I. Ordway III, 1964. Pp. xvii + 334. Price \$13.00.

*Advances in Virus Research* (Vol. 10). By K. M. Smith and M. A. Lauffer, 1963. Pp. viii + 277. Price \$11.50.

*Chemical Applications of Infra-Red Spectroscopy*. By C. N. R. Rao, 1964. Pp. xiii + 683. Price \$19.50.

*The Formation of Wood in Forest Trees*. Edited by M. H. Zimmermann, 1964. Pp. xv + 562.

## SCIENCE NOTES AND NEWS

### Conference on Atomic Spectra and Radiation Processes

The Institute of Physics and the Physical Society announces that a Conference on Atomic Spectra and Radiation Processes is to be held in the Clarendon Laboratory, Oxford, on 12, 13 and 14 April 1965.

The Conference will be concerned with the interpretation of spectra in terms of atomic and nuclear structure, with the interaction between light and atoms, and with the interaction between radiating atoms and their environment. The sessions on spectra will include discussions of multiplet and hyperfine structure measured by the techniques of optical spectroscopy, double-resonance, level-crossing, optical pumping, and atomic beam resonance. The discussion of interaction processes will include the theories of optical pumping cycles, and of strong light fields. Sessions will be devoted to discussions of transition probabilities, populations, and the pressure broadening of spectral lines.

The number of participants will be limited to approximately 120 and attendance will be by invitation only. Those interested in obtaining an invitation and who wish to submit papers should apply for further details to the Administration Assistant of the Institute of Physics and the Physical Society, 47 Belgrave Square, London, S.W. 1, as soon as possible.

### UNESCO South Asia Science Co-operation Office, New Delhi—Courses in Plant Physiology and Soil Biology

The UNESCO South Asia Science Co-operation Office in New Delhi is offering two post-graduate courses: (1) problems connected with plant physiology and (2) Soil biology.

The first course which will be conducted in collaboration with the Department of Botany, University of Delhi, will be for four weeks from 10 December 1964 to January 10, 1965 and would cover all aspects of plant physiology but with a stress on modern developments in the subjects such as photosynthesis, hormones, growth, tissue culture, protein and nucleic acids and morphogenesis.

The second course on Soil biology will be in collaboration with the Department of Agriculture, Government of India, New Delhi, and will last for six weeks (on dates to be announced) during December 1964 to February 1965.

Further information in connection with the two courses can be obtained from: The Director, UNESCO South Asia Science Co-operation Office, New Delhi, Southern Extension I, New Delhi-3.

### Equatorial Undercurrent

An "underwater river" flowing eastward in the Atlantic along the Equator at nearly three miles an hour has been detected by an international fleet of research vessels in both summer and winter. This preliminary result was announced at the third session of the Intergovernmental Oceanographic Commission meeting from June 10 to 19, 1964, at UNESCO House in Paris.

The investigation of the tropical Atlantic began with a winter phase from February to April 1963, when fourteen ships from seven countries ran north-south transects across the Equator from South America to Africa. It was then that the existence of this equatorial undercurrent, first noticed by a cable-laying vessel at the end of the 19th century, was confirmed.

The next step was to learn if the current continued in summer. From August to September last year, more transects were made by eleven ships from eight countries. Once again, they found this undercurrent "tagged" by high salinity so that it could be easily traced. It appeared to oscillate in a zone 100 miles north and 100 miles south of the Equator at depths between 100 and 200 feet.—(UNESCO Press, Release No. 2517.)

### Superconductivity in Semiconductors

Recently there has been some speculation on the possible existence of superconductivity in semiconductors, and the relevance of several material parameters has been discussed. Of these, the criteria of high charge carrier concentration, large effective mass, many valleys and large dielectric constants are met in reduced strontium titanate  $\text{SrTiO}_3$ , so that a search for a superconducting transition in this substance seemed appropriate.

M. L. Cohen (Bell Telephone Laboratories) and J. F. Schooley and W. R. Hoster (National Bureau of Standards) have reported the finding of superconducting transitions in three samples of reduced strontium titanate. In two of the specimens the transition occurred within a range of less than  $0.1^\circ \text{K.}$  at about  $0.25^\circ \text{K.}$  and  $0.23^\circ \text{K.}$

The reduced samples were prepared from single crystals of  $\text{SrTiO}_3$ . The superconducting transitions were observed by cooling the specimens by thermal contact through Apiezon N grease with single crystals of chromium potassium alum in an adiabatic demagnetization apparatus.—(*Phys. Rev. Letters*, 27 April 1964.)

#### Ferroelectric Behaviour of Ice

In substances which contain hydrogen-bonds between two O-atoms (e.g., Rochelle salt) the ferroelectric behaviour is due to the proton jumping from one possible position between the O-atoms to the other one. It is known that ice contains hydrogen-bonds of the above type, and so it was expected to be ferroelectric in suitable temperature regions. But there was no experimental evidence till now.

In a recent communication to *Physics Letters* investigators from Technische Hochschule, Munich, describe experiments which seem to show the ferroelectric behaviour of ice. The ferroelectricity appears at very low temperatures of about  $100^\circ \text{K}$ . with a relaxation time of the order of hours. Probably these factors supply the reasons why ferroelectricity of ice could not be detected before.

It was noted that the ferroelectric behaviour of ice could be obtained only if the water used for the crystal growth was not extremely pure. This shows that foreign atoms promote the appearance of ferroelectricity. It is not clear whether this influence is due to a shortening of the relaxation time of the ferroelectric polarization or whether the foreign atoms themselves contribute to the charge displacement.—(*Physics Letters*, 1 May 1964.)

#### Water Vapour in the Atmosphere of Venus

With the development of modern spectrophotometric techniques it is possible to estimate quantitatively with reasonable accuracy the amount of water vapour present in the atmosphere (above the reflective cloud layer) of the planet Venus. Such a determination has been made with an automatic daytime telescope of 30-cm. aperture carried by balloon to 26.5 km. Radiation (sunlight reflected from Venus) was measured in the band at  $1.13 \mu$  with a grating spectrometer of  $2 \text{ \AA}$  resolving power. This portion of the spectrum was scanned once every 10 seconds with a set of 21 exit slits arranged

to match 21  $\text{H}_2\text{O}$  absorption line groups. The radiation passing through was received by a cooled photomultiplier with S-1 surface, and its response was recorded on paper.

From 120 such records it was found that the modulation produced by the water absorption, when the line groups were scanned, was  $10.5 \pm 0.5\%$ . By calibration, this modulation is the same as that produced by  $9.8 \times 10^{-3} \text{ gm./cm.}^2$  of water vapour at atmospheric pressure. It was ascertained by further measurements that the telluric water vapour (above the altitude of the balloon) played a minor role in the 10.5% modulation.—(*Astrophys. Jour.*, 1964, 139, 1021.)

#### Structure of Carbon Suboxide $\text{C}_3\text{O}_2$

The linear structure of the carbon suboxide ( $\text{C}_3\text{O}_2$ ) molecule has been a matter of scientific controversy for over 30 years. The electronic structure expected for  $\text{C}_3\text{O}_2$ , as well as valence theory in general, indicates that  $\text{C}_3\text{O}_2$  has a linear symmetrical structure. In 1932, however, investigators reported a dipole moment that indicated a bent structure for this molecule. Since that time molecular spectroscopists have been divided in their opinion about the structure.

According to a National Bureau of Standards Report, high-resolution infra-red spectroscopic studies show conclusively that the  $\text{C}_3\text{O}_2$  molecule is a straight chain of three carbon atoms with an oxygen atom at each end.

The NBS-built high-resolution infra-red spectrometer which was used to study the region  $1800\text{--}3300 \text{ cm.}^{-1}$  was operated in the double pass mode after being calibrated, using rare gas emission spectra with an interference fringe system. The resolution obtained was  $0.03 \text{ cm.}^{-1}$  in the  $3180 \text{ cm.}^{-1}$  region. A liquid nitrogen-cooled lead sulphide detector and a grating having 10,000 lines/in. were used.

The  $\text{C}_3\text{O}_2$  band centred at  $3200 \text{ cm.}^{-1}$  fortunately falls in the region of peak resolution for the NBS instrument. Infra-red spectrum of  $\text{C}_3\text{O}_2$  showed a series of resolved absorption bands. This absorption is assigned to a ground state transition which is accompanied by a large number of "hot bands". An analysis of the rotational structure of the ground state transition and of the first "hot band" showed that the selection rules established for a linear molecule are followed.—(*Jour. Frank. Inst.*, 1964, 277, 379.)

# NUCLEAR MAGNETIC RESONANCE IN METALS AND ALLOYS

S. S. DHARMATTI AND R. VIJAYARAGHAVAN

*Tata Institute of Fundamental Research, Bombay-5*

## INTRODUCTION

THE subject of nuclear magnetic resonance (NMR) is now too well known to need any introduction of the basic concepts. Excellent reviews<sup>1-3</sup> have appeared earlier giving comprehensive details of both the theory and the experimental data with their interpretation. In this paper, we shall attempt to present the recent developments regarding NMR, in metals and alloys with particular emphasis on the work done in the authors' laboratory.

## THEORY

The essential difference between a metal and an insulator is that the former is conducting and the conduction electrons are responsible for the two main different behaviours of metals from non-metals. One is the skin effect due to which the radio-frequency magnetic field cannot penetrate the metallic surface more than the depth of an order of  $5 \times 10^{-3}$  cm. As a result metallic powders or thin foils or sheets are used in NMR experiments. The second one arises from the magnetic effects of conduction electrons which will be described later. When a metal powder is placed in a magnetic field  $H_0$ , the electron spins are partially polarised to give rise to spin paramagnetic susceptibility or better known as Pauli susceptibility,  $\chi_p$ , per unit volume. The polarisation in turn produces a field  $\Delta H$  at the position of nuclei due to *s*-state hyperfine interaction. The field  $\Delta H$ , thus caused mostly by *s*-electrons, must be added to  $H_0$  and consequently the resonance is shifted from its position in an insulator. This shift is generally known as the "Knight Shift", named after its discoverer. We shall presently write down a theoretical expression for the shift.

$$\frac{\Delta H}{H_0} = \frac{8\pi}{3} \chi_p V_0 \langle |\psi(0)|^2 \rangle \quad (I)$$

Here  $V_0$  is the atomic volume and  $\psi$ , the electronic wave function normalised over  $V_0$ . The average spin density is taken over the Fermi surface.

Several consequences follow immediately such as (1) the shift is positive as all the quantities on the right-hand side of equation (I) are positive; (2) the resonance frequency in a metal is shifted higher for a fixed field  $H_0$ ; (3) the

shift is proportional to  $H_0$  and is rather large for elements with higher atomic number; (4) it is relatively small if conduction electron wave functions are essentially of non-*s* type and finally (5) it is largely independent of temperature. These results have been verified experimentally, and it can be said that the origin of the shift has been understood clearly. In view of Knight's review<sup>2</sup> and Rowland's recent book<sup>4</sup> on this subject, we shall, in this paper, be mainly interested in supplementing rather than duplicating their work.

The study of physical properties of alloys is quite fascinating for several reasons. The original character of both host and guest metals is likely to be changed and these changes are of interest to physicists, chemists as well as to metallurgists. In NMR, we are primarily interested in the variation of Knight shift in an alloy and consequently would like to understand the changes that take place in the quantities of equation (I). In early experimental work two facts stood out prominently. They were: (1) within a given phase the resonance frequencies of both solvent and solute atoms were nearly independent of composition and (2) discontinuous jumps in frequency occurred across a phase boundary. Knight's later work<sup>5</sup> on liquid metals showed however that there was not much change in the resonance frequency on melting and, therefore, state of short-range order is more important for Knight shift values than crystal structure parameters.

In general, the interaction Hamiltonian will contain (i) a Knight shift term, (ii) an anisotropic shift term in non-cubic crystals and in crystals lacking local cubic symmetry, (iii) a quadrupolar interaction term for nuclei with spin  $I > \frac{1}{2}$ , (iv) a dipolar and a pseudo-dipolar interaction terms between like and unlike nuclear neighbours and (v) an indirect spin-spin interaction term. The first two are directly dependent on field; the quadrupolar term to a first order will be independent of the field and in second order inversely proportional to the field. The other terms have no field dependence at all. All these effects have great influence on the NMR position, line shape and width in metals and alloys and, therefore, the NMR study can well be used to evaluate their physical properties.

## EXPERIMENTAL METHOD

Any NMR apparatus should be good enough for observing the resonance in metals. No high stability oscillator or field is essential as the lines are generally broad. But it is necessary to have the sample size less than the skin-depth at the operating frequency. Otherwise, the lineshape will be a function of the size and may mislead the interpretations. It is enough if the sample size is about 100 microns or less for the normal operating frequencies. Commercial purity of the sample will be quite sufficient. In Table I the Knight shift values per cent ( $\Delta H/H\%$ ) from those of insulator are arranged in the order in which they appear in the Periodic Table. Data for metals of various transition series are grouped separately as they show departures from the general rules in having temperature dependence and, at times, negative Knight shifts. NMR in ferromagnets, and antiferromagnets will be dealt with in the last part of this paper.

theory. In transition metals, however, not much of a generalisation seems to be possible; because most of them have temperature-dependent Knight shifts and some of the shifts are even negative. By negative shifts, we mean that in a fixed field, the resonance frequency of an alloy or metal occurs at lower frequency than that of a most diamagnetic insulator. The origin of such shifts is different from what we obtain from equation (I).

## APPLICATIONS

Several papers on the applications of NMR to the study of metals have appeared<sup>4</sup> but it is not the object of this article to review all of them. It is intended, here, to discuss mainly the authors' own work with reference to such papers as have a bearing on it.

(a) *NMR in Sodium Alloys*.—Sodium is an alkali metal with one valence electron. NMR of  $\text{Na}^{23}$ , the only isotope with 100% abundance and spin  $I = 3/2$ , has been observed both in metals and in aqueous solution

TABLE I  
Knight shifts in percentage

I A		I B		II A		II B	
$^3\text{Li}^{6,7}$	0.026	..	..	$^4\text{Be}^9$	0	..	..
$^{11}\text{Na}^{23}$	0.112	..	..	$^{12}\text{Mg}^{25}$	0.111	..	..
$^{19}\text{K}^{41,39}$	0.265	$^{29}\text{Cu}^{63}$	0.222	$^{20}\text{Ca}^{43}$	..	..	..
$^{37}\text{Rb}^{85,87}$	0.65	$^{47}\text{Ag}^{107,109}$	0.522	$^{38}\text{Sr}^{87}$	..	$^{48}\text{Cd}^{111,113}$	0.415
$^{55}\text{Cs}^{137}$	1.49	..	..	$^{56}\text{Ba}^{135,137}$	0.403	$^{80}\text{Hg}^{199}$	2.46

III		IV		V B		VI B	
$^{13}\text{Al}^{27}$	0.161	$^{14}\text{Si}^{29}$	0	..	..	..	..
$^{31}\text{Ga}^{69,71}$	0.449	..	..	..	..	..	..
$^{49}\text{In}^{113,115}$	0.786	$^{50}\text{Sn}^{117,119}$	0.72	..	..	$^{34}\text{Se}^{79}$	0
$^{81}\text{Tl}^{203,205}$	1.56	$^{82}\text{Pb}^{207}$	1.47	$^{83}\text{Bi}^{209}$	1.45	$^{52}\text{Te}^{123}$	0

Metals of transition series							
$^{21}\text{Sc}^{45}$	0.24	$^{23}\text{V}^{51}$	0.56	$^{24}\text{Cr}^{53}$	0.69	$^{25}\text{Mn}^{55}$	-0.13
$^{39}\text{Y}^{89}$	0.34	$^{41}\text{Nb}^{93}$	0.85	$^{42}\text{Mo}^{95,97}$	0.58	$^{43}\text{Tc}^{99}$	0.61
$^{57}\text{La}^{139}$	0.63	$^{73}\text{Ta}^{181}$	1.1	$^{74}\text{W}^{183}$	1.06	..	..
						$^{78}\text{Pt}^{195}$	-3.52

From Table I, it is obvious that as the atomic number increases in a given column of the Periodic Table, the Knight shift is found to increase. This is primarily because the hyperfine constant increases with atomic mass. It is smaller where the conduction electron wave functions are mostly of non-s character as we have in silicon, tellurium and selenium. The temperature dependence of Knight shift is also found to be very small in agreement with the

There exists a positive Knight shift of 0.11% in sodium metal. Since the conduction electron wave functions are fairly well known in an alkali metal, the shift was also calculated theoretically with very few assumptions and the agreement is found to be very satisfactory. Na<sup>23</sup> signal in metal is very strong and the width is mostly determined by the magnetic field inhomogeneities. That it should be so in a solid, need not perplex us, as there is consider-



able diffusion of sodium atoms at ordinary temperatures which averages all dipolar effects. This aspect has been taken advantage<sup>6</sup> of in the preparation of a series of alloy systems with mercury, lead and tin for the study of the Knight shifts and the linewidths of the con-

alloys, we can presume that the two alloys are similar in structure. However, even if one of them changes, we can distinguish the two alloys and the phase change that occurs between them. Using these criteria we will now analyse our experimental results (Table II).

TABLE II  
Knight shifts of  $\text{Na}^{23}$  and  $\text{Hg}^{199}$  and linewidths of  $\text{Na}^{23}$

Alloy	Atomic % Na	$\text{Na}^{23}$ Knight shift $\times 10^{-4}$	$\text{Na}^{23}$ R.M.S. line width in gauss	$\text{Hg}^{199}$ Knight shift $\times 10^{-4}$	Remarks
$\text{NaHg}_4$ (hexagonal)	.. 20	$5.29 \pm 0.11$	$0.18 \pm 0.02$	$210 \pm 3$	X-ray not taken for this phase due to experimental difficulty.
$\text{NaHg}_2$ (hexagonal)	.. 33.3	$4.69 \pm 0.11$	$0.65 \pm 0.10$ (sharp line)	$132 \pm 15$	In addition a second order $\text{Na}^{23}$ line obtained.
$\text{NaHg}$ (orthorhombic)	.. 50	$5.93 \pm 0.33$	Two quadrupolar broadened lines	$46 \pm 5$	Two inequivalent sites for Na.
$\text{Na}_3\text{Hg}_2$ (tetragonal)	.. 60	$9.16 \pm 0.22$	$0.45 \pm 0.05$ (sharp line)	$86 \pm 3$	Two lines for $\text{Na}^{23}$ due to inequivalence of sites.
$\text{Na}_5\text{Hg}_2$ (hexagonal)	.. 71.4	$9.36 \pm 0.11$	$0.46 \pm 0.05$	$85 \pm 3$	A single $\text{Na}^{23}$ line. Hence a phase change detected.
$\text{Na}_3\text{Hg}$	.. 75	$10.56 \pm 0.05$	$0.07 \pm 0.02$	$78 \pm 5$	Structure not known

stituent nuclei. We will, in this paper, be mainly concerned with the sodium amalgam systems.

Sodium forms solid solution with mercury and also certain known intermetallic compounds having definite structures. These have been prepared and verified by X-ray techniques.

Mercury has two stable isotopes  $\text{Hg}^{199}$  and  $\text{Hg}^{201}$  both having abundances less than 20%. The respective nuclear spins are  $I = \frac{1}{2}$  and  $\frac{3}{2}$  and the metallic shift is 2.56%. In Table II, we have presented the Knight shifts and the linewidths of  $\text{Na}^{23}$  and the Knight shifts of  $\text{Hg}^{199}$  in sodium amalgams. The linewidths of  $\text{Hg}^{199}$  are not given as we have only taken dispersion signals which do not represent the true widths. We shall now discuss how far the NMR is able to distinguish the phase changes in an alloy system.

The intermetallic compounds formed between 20 and 80 atomic per cent sodium are  $\text{NaHg}_4$ ,  $\text{NaHg}_2$ ,  $\text{Na}_7\text{Hg}_8$ ,  $\text{NaHg}$ ,  $\text{Na}_3\text{Hg}_2$ ,  $\text{Na}_5\text{Hg}_2$ , and  $\text{Na}_3\text{Hg}$  and each one has a distinct crystal structure of its own. The crucial question is how to distinguish one from the other. X-ray crystallographers can identify them by the different X-ray patterns characteristic of every one of them. In NMR the Knight shifts and linewidths of sodium and mercury resonances in each alloy are the main features for distinguishing the phases or structures. If the Knight shifts, the number of resonant lines and linewidths of sodium and mercury remain the same in two

The Knight shifts of  $\text{Na}^{23}$  in  $\text{NaHg}_4$ ,  $\text{NaHg}_2$  and  $\text{NaHg}$  are almost the same. But the shifts for  $\text{Hg}^{199}$  resonance in  $\text{NaHg}_4$ ,  $\text{NaHg}_2$  and  $\text{NaHg}$  are all different; so we conclude that phase changes have taken place between the three alloys. Similarly  $\text{Na}^{23}$  in  $\text{Na}_3\text{Hg}_2$  and  $\text{Na}_5\text{Hg}_2$  has different Knight shifts while it is the same for  $\text{Hg}^{199}$ . So again a phase change is detected using the resonance of one of the constituents, though the other one is unhelpful in deciding the change.

Let us now look into the linewidths of  $\text{Na}^{23}$  and compare them with its Knight shifts. The linewidth of  $\text{Na}^{23}$  in  $\text{NaHg}_4$ ,  $\text{NaHg}_2$  and  $\text{NaHg}$  are different though their shifts are the same. This phase change is, therefore, identified from linewidth consideration. It is better to recall that the Knight shift is caused by the conduction electron hyperfine interaction, while linewidth changes are by differing electric quadrupolar interaction or nuclear dipolar interaction. The latter mechanisms can be a direct consequence of structural changes between the alloys though conduction electron band is nearly identical in these alloys.

To summarise, we need to check the linewidths and the resonances of the constituent nuclei comprising the alloys to detect a phase change rather than relying on any one of them only.

As in insulators, change of temperature causes changes in internal motion or self-diffusion and crystal structure of metals and alloys. They

can be studied by following the linewidths at various temperatures and sometimes observing two resonances in the two phase regions. Since this is not exclusively in the domain of metal physics but embraces a larger area of solid state physics, we will not discuss them except to mention that such effects have been observed in Na-Hg system and will be reported later.<sup>6</sup> Similarly inequivalent atomic sites in an alloy produce multiple resonances as in solids, the number of lines denoting the number of inequivalent positions (see Table II). For example, in sodium amalgams containing 35.77, 51.87 and 68.6 at. % Na, a broad line of  $N_{\text{H}}^{23}$  is observed due to second order quadrupolar interaction in addition to a narrow line. This shows that in alloys  $\text{NaHg}_2$ ,  $\text{NaHg}$  and  $\text{Na}_2\text{Hg}$ , there are at least two inequivalent crystallographic sites for sodium. In  $\text{NaHg}_2$ , however, contrary to NMR observation, crystallographers predict only one type of sodium site. We will now pass on to consider other types of Knight shifts involving change of sign.

(b) *Transition Metals*.—In Table I, it can be seen that some of the shifts are negative and they are to be found mostly among transition metals. Further, the shifts, in a transition metal or in a rare earth alloy, are invariably temperature-dependent. These two features distinguish them from normal Knight shifts. We shall now discuss the relevant theories concerning these shifts along with experimental details.

#### KNIGHT SHIFT IN PLATINUM ALLOYS

Rowland<sup>7</sup> observed that the Knight shift of  $\text{Pt}^{195}$  in platinum metal is large, negative and temperature-dependent. It is a transition metal with an atomic configuration  $5d^96s$ . It has one isotope with spin  $I = \frac{1}{2}$ . It is generally believed that this unusual shift in this metal arises due to the polarisation of core or inner s-electrons (already filled) by exchange interaction with the d-electrons in the unfilled  $5d$  band.<sup>8</sup> Let us assume that the majority of d-electrons point parallel to the field  $H_0$ . These have a stronger interaction with parallel core s-electrons and pull them nearer to themselves, leaving antiparallel s-electrons closer to nucleus. This results in a net negative spin density at the nucleus and thus the origin of negative shift is understood. Certainly, conduction s-electrons will still give a positive spin density at the nucleus obeying equation I but the magnitude of the shift will now depend on which of the two is greater. In platinum, it is believed that the s-part of the conduction

electron gives a positive shift of 1.2% while the core s-electrons give a negative shift of 4.72% with the result the total shift becomes  $-3.52\%$  with respect to chloroplatinic acid or  $-2.98\%$  with reference to a most diamagnetic platinum complex. Evidently, the contribution from d-electrons is proportional to the d-electron susceptibility and therefore the shift is temperature-dependent. The total shift  $K$  can be written as

$$K = a\chi_s + b\chi_d(T). \quad (II)$$

Here  $a$  and  $b$  are constants and the first term is temperature-independent. The increase in  $\chi_d$  at lower temperature increases the negative shift as well.\*

In alloying a transition metal with a non-transition metal there is a possibility that the d-band will get gradually filled up and in effect, the large negative shift should decrease. We have studied Pt-Sn, Pt-Pb and Pt-Hg systems.<sup>9</sup> The alloys were powdered, and annealed. The compounds formed were confirmed by X-ray studies and the results of the Knight shifts are shown in Table III. The significant decrease in

TABLE III  
Knight shifts of  $\text{Pt}^{195}$ ,  $\text{Sn}^{119}$ ,  $\text{Pb}^{207}$  and  $\text{Hg}^{199}$   
in different alloys at temperatures  
—  $157^\circ\text{C}$ . and  $24^\circ\text{C}$ .

Alloy	Atomic % Pt	$\text{Pt}^{195}$ Knight shift%		$\text{Sn}^{119}$ Knight shift%	
		At $24^\circ\text{C}$ .	At $-157^\circ\text{C}$ .	At $24^\circ\text{C}$ .	At $-157^\circ\text{C}$ .
Pt metal	100	-2.98	-3.43 (at $-191^\circ\text{C}$ .)	..	..
$\text{Pt}_3\text{Sn}$	75	-0.27	-0.44	-0.02	-0.05
$\text{PtSn}$	50	0.46	..	0.60	..
$\text{Pt}_2\text{Sn}_3$	40	0.54	..	0.72	..
$\text{PtSn}_2$	33.3	0.39	0.38	1.06	1.06
$\text{PtSn}_4$	20	0.30	..	0.70	..
Sn metal	..	..	..	0.73	0.73
$\text{Pb}^{207}$ Knight shift%					
Pb metal	..	..	..	1.47	+1.47
$\text{Pt}_3\text{Pb}$	75	-0.29	-0.46	-0.52	-0.61
$\text{Hg}^{199}$ Knight shift%					
Hg metal	..	..	..	2.46	..
$\text{PtHg}$	50	0.67	0.67	1.24	..
$\text{PtHg}_2$	33.3	0.55	0.55	0.53	..

\* After the completion of this work, the authors noticed a very recent paper by Clogston, Jaccarino and Yafet<sup>17</sup> which treats extensively the theoretical aspects on Knight shifts in transition metals particularly in platinum.

value in all compounds from pure metal that  $d$ -electron band is progressively filled and it is even possible to fill them completely to give a net positive shift. The temperature-dependence follows obviously from (11). The susceptibility measurements, as made, are in good accord with the shifts. For example, the susceptibility of pure Pt metal is  $10^{-6}$  emu/gm. at  $300^\circ\text{K}$ . which increases to  $10^{-6}$  emu/gm. at  $78^\circ\text{K}$ . The large temperature-dependence in this metal is due to unfilled  $d$ -electron band. The shift of  $\text{Pt}^{195}$  is  $+0.39\%$  at  $297^\circ\text{K}$ . (with practically no temperature-dependence) and the alloy is to be diamagnetic. The same trend is seen in other alloys too.

The shifts of  $\text{Pt}^{195}$  in  $\text{Pt}_3\text{Sn}$  and  $\text{Pt}_3\text{Pb}$  are nearly equal and the compounds are also structurally isomorphous.  $\text{Sn}^{119}$  and  $\text{Pb}^{207}$  shifts in these alloys are negative with strong temperature-dependence, though large temperature-dependent positive shifts are observed in pure  $\text{Sn}$  and  $\text{Pb}$ . This clearly proves that  $d$ -electron character, present in pure tin or lead metal, is suppressed in the alloys due to interference with  $5d$  band of platinum and the  $s$ -character prevails at their respective nuclear sites.

We have not, as yet, examined completely line widths and their shapes in these alloys. They are in themselves very interesting. The shift of  $\text{Pt}^{195}$  ranges from 2.5 gauss to 40 gauss in some cases, the shapes are markedly asymmetric as in  $\text{Pt}_3\text{Sn}$  and  $\text{Pt}_3\text{Pb}$  even though in overall structures are cubic. Also the other broadening mechanisms, mentioned earlier, play a prominent part in determining the width.<sup>9</sup>

**(c) NMR in Ferromagnets.**—The observation of NMR in a ferromagnet was first made by Slichter and Portis<sup>10</sup> in cobalt metal. The  $\text{Co}^{59}$  resonance was recorded without any external field and the signal was very strong. The frequency at room temperature was 213.1 Mc./s. corresponding to an internal field of 213.4 kilogauss at  $\text{Co}^{59}$  nuclear site. The large strength of the signal arises due to the nuclei in domain walls where the applied r.f. field is enhanced by enough wall motion by a factor of a thousand in zero external field. Predictably the enhancement goes down when an external field is applied now the original enhancement of r.f. amplitude decreases due to the disappearance of domain walls. Temperature-dependence of the resonance frequency confirmed the applicability of spin-wave<sup>10</sup> theory to cobalt. Soon, similar resonances were recorded of  $\text{Fe}^{57}$  and  $\text{Ni}^{61}$  at

45.6 and 29 Mc./s. in iron and nickel respectively.<sup>11-12</sup> The corresponding internal fields are 330.5 and 170 kilogauss. The fields at nuclear sites in all cases have been opposed to the magnetisation in ferromagnetic domain and if iron and nickel were paramagnetic metals we would have obtained negative Knight shifts as the foregoing theory in the  $\text{Pt}^{195}$  negative shift applies here as well. The local field at the nucleus arises due to the contact interaction of the nuclei with core  $s$ -electrons which have suffered exchange interaction with  $3d$ -electrons. Chromium is a paramagnetic metal till  $40^\circ\text{C}$ . (Neel temperature) and NMR of  $\text{Cr}^{53}$  was observed<sup>13</sup> below this temperature, giving a positive shift of 0.69%. Above the Neel temperature, the resonance could not be observed as the metal becomes antiferromagnetic. The transition temperature in this metal could be determined by NMR with an accuracy of  $0.5^\circ\text{C}$ . as in neutron diffraction measurements.

**(d) NMR in Rare-earth Alloys.**—So far we have seen how unfilled  $d$ -band influences the NMR in transition metals and their alloys. The effect has been felt mostly on the nuclei whose atom has incomplete  $d$ -shell. We will now deal with cases where the conduction electron is polarised by rare-earth spins and the effect is observed in an element which is alloyed with rare-earth metal. Originally even ferromagnetism in the  $3d$  metals was attributed to an indirect interaction between the local  $3d$  spins and the  $4s$ -conduction electrons. The crucial point is that the  $d$ -spins impress a uniform polarisation on the conduction electrons. NMR is just the right method to test this hypothesis.

Owen *et al.*<sup>14</sup> have studied the Knight shift of copper in very magnetically dilute Mn-Cu alloys. If the polarisation of the copper conduction electrons were uniformly enhanced by exchange interaction with Mn atoms, then an additional shift is expected. Experimentally, no such shift was observed but a broad line was obtained whose width was directly proportional to the field and inversely proportional to the temperature as in susceptibility. The absence of shift was attributed to short-range character of polarisation and randomness of Mn spins. Subsequently, in a more dense and ordered structure ( $\text{XAl}_2$ ), where X is a rare-earth element, large temperature-dependent shifts of  $\text{Al}^{27}$  were observed,<sup>15</sup> which could be consistent with the negative polarisation of the conduction electron spins by rare-earth ion spins,

The sign of the shifts seemed to obey a simple rule. If we designate  $\vec{S}$ ,  $\vec{L}$  and  $\vec{J}$  as the spin, orbital and total angular momentum of the ground state of the rare-earth ion, then the shift  $K$  is positive for  $\vec{J} = \vec{L} - \vec{S}$  and negative for  $\vec{J} = \vec{L} + \vec{S}$ . Also

$$K = K_0 \left[ 1 + \frac{\tau_{sf} \chi_f \langle \vec{S} \cdot \vec{J} \rangle}{g_f g_s n_f \mu_B^2 J(J+1)} \right]. \quad (\text{III})$$

Here  $K_0$  is the Knight shift in the absence of  $f$ -electron polarisation,  $\chi_f/n_f$  the  $f$ -electron susceptibility per rare-earth ion at temperature  $T$ ,  $\mu_B$  the Bohr magneton and ' $g$ 's denote respective  $g$ -factors. Since  $\langle \vec{S} \cdot \vec{J} \rangle < 0$  for  $\vec{J} = \vec{L} - \vec{S}$  and  $\langle \vec{S} \cdot \vec{J} \rangle > 0$  for  $\vec{J} = \vec{L} + \vec{S}$ , the observed shifts are consistent with a negative  $\tau_{sf}$  which denotes the interaction term between the rare-earth ion spin and the conduction electron spin.

We prepared two alloys:  $\text{NdSn}_3$  and  $\text{USn}_3$ , which have ordered cubic structures. According to equation (III), a positive shift for  $\text{Sn}^{119}$  is expected in both. The experimental values are<sup>16</sup>

In  $\text{NdSn}_3$ ,  
 $K_{\text{Sn}^{119}} = 1.6\%$  at  $300^\circ \text{K.}$  and  $2.75\%$  at  $121^\circ \text{K.}$

In  $\text{USn}_3$ ,  
 $K_{\text{Sn}^{119}} = 2.75\%$  at  $300^\circ \text{K.}$  and  $4.51\%$  at  $133^\circ \text{K.}$

$K_{0\text{Sn}^{119}} = 0.7\%$  in pure tin at all temperatures.

These results are entirely in agreement with the theory in magnitude and in temperature dependence. The other alloys in this series will be studied in due course.

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## FREE AMINO ACIDS AND AMIDES IN LEGUME ROOT NODULES\*

N. RAJAGOPALAN

University Botany Laboratory, Madras-5

**R**OOT nodules of legumes contain haemoglobin,<sup>1</sup> fix nitrogen,<sup>2</sup> have been shown to possess amino-acid activating enzymes,<sup>3</sup> and hence are a probable site of protein synthesis. Although information on free amino acids in nodules which may constitute the initial products of fixation<sup>4</sup> is available with temperate legumes,<sup>5-7</sup> little is known concerning typically tropical legumes. Steward and Thompson<sup>8</sup> suggested that the composition of the non-protein nitrogen fraction of root nodules requires further elucidation. This paper outlines exploratory experiments on root nodules

of species of *Arachis*, *Phaseolus*, *Vigna*, *Cyamopsis*, *Dolichos*, *Centrosema*, *Psophocarpus*, *Clitoria* and *Gliricidia*, belonging to *Papilionatae*.

Nodules from each species, grown in an uncultivated virgin soil and inoculated with effective cow-pea rhizobia, were excised prior to flowering time. The haemoglobin content of root nodules reaches a maximum at this period indicative of maximum nitrogen-fixing activity as estimated.<sup>10-12</sup>

Free amino acids and amides extracted from 10.0 g. fresh homogenized nodules were identified and quantitatively estimated by two-dimensional chromatography following the

\* Part of author's Doctoral Thesis, University of Madras.

directions of Steward and Thompson,<sup>9</sup> Stepka,<sup>13</sup> and Porter *et al.*<sup>14</sup> Chromatograms with an assay area of 10" × 15" were run in phenol-water (100 : 39 w/v) and *n*-butanol-acetic acid-water (100 : 22 : 50 v) for the first and second solvent systems, dried and sprayed with 0.4% solution of ninhydrin in 95% (v/v) ethanol. The colour from individual spots cut into areas of approximately 1 cm.<sup>2</sup> was eluted in 50% ethanol. The quantity of amino acid was determined against blanks in a Hilger 'Uvispek' photoelectric spectrophotometer using a 10 mm. light path within two hours from four separate chromatograms. Absorption of all the fractions (amino acids) was read at 570 mμ and for asparagine at 360 mμ. The quantity of amino acids or amide was determined with reference to standard curves relating absorption of the ninhydrin derivative to weight of the pure amino acid chromatographed similarly and quantitatively estimated.

The amounts of free amino acids and amides as percentage of total soluble nitrogen of root nodules of the nine legumes are shown in Table I.

(42.3%) and *Gliricidia* (30.5%), followed by *Arachis* (24.5%), *Psophocarpus* (21.8%), *Vigna* (20.7%) and *Dolichos* (20.5% to 15.1%). Nodules of *Phaseolus*, *Clitoria* and *Cyamopsis* had smaller quantities of this amide (9.8%, 8.5% and 6.7% respectively). Glutamine has

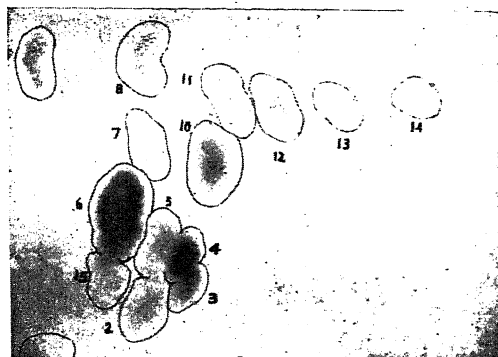


FIG. 1. Paper chromatogram of amino acids from the root nodules of *Cyamopsis tetragonoloba* (L.) Taub., showing the high content of asparagine. 1. Cys., 2. Asp., 3. Gly., 4. Gly., 5. Ser., 6. Asp.NH<sub>2</sub>, 7. Arg., 8. His., 9. Unknown., 10. Glu.NH<sub>2</sub>, 11. α-Amb, 12. Ala., 13. Val., 14. Leu., 15. Orn.

TABLE I

Free amino acid and amide fractions as percentage of total soluble nitrogen of legume root nodules

Amides and amino-acids	<i>Arachis hypogaea</i>	<i>Phaseolus mungo</i>	<i>Vigna catjang</i>	<i>Cyamopsis tetragonoloba</i>	<i>Dolichos biflorus</i>	<i>Dolichos lab lab</i>	<i>Psophocarpus tetragonoloba</i>	<i>Gliricidia macrocarpa</i>	<i>Centrosema pubescens</i>	<i>Clitoria ternatea</i>
Amides ..	44.0	9.9	21.0	88.8	20.0	34.3	34.5	56.2	76.4	21.5
Amino acids :										
Acidic ..	17.5	25.0	21.5	2.3	20.4	14.6	10.2	4.8	4.9	38.2
Basic ..	19.8	13.3	23.0	2.0	16.0	14.3	16.8	12.5	5.3	15.5
Cyclic Imino ..	..	4.5	..	..	..	..	..	..	..	..
Aromatic ..	..	..	..	..	1.3	1.6	..	..	..	..
Sulphur ..	..	..	1.1	0.5	1.2	4.9	..	1.2	..	..
Hydroxy ..	2.7	17.7	3.0	0.6	4.9	2.8	2.4	2.2	..	1.7
Neutral ..	16.0	29.6	30.4	5.8	36.2	27.5	36.1	23.1	13.4	23.1

Amides (ASP.NH<sub>2</sub>, GLU.NH<sub>2</sub>); Acidic (ASP, GLU, γ-MET, GLU); Basic (ARG, ORN, HIS); Cyclic Imino (PRO, PIP); Aromatic (PHE, TRV, TYR); Sulphur (CYS, MET, S-MET, CYS); Hydroxy (SER, THR); Neutral (GLY, ALA, VAL, LEU, α-AMB, γ-AMB).

Asparagine and glutamine (amide fraction) constitute a large percentage of the soluble N in nodules of *Arachis*, *Gliricidia*, *Centrosema* and *Cyamopsis*.

The quantity of asparagine was highest in nodules of *Cyamopsis* (Fig. 1) (82.1%) followed by *Centrosema* (34.1%), *Gliricidia* (25.7%) and *Arachis* (19.5%). Glutamine occurred in large quantities in *Centrosema*

earlier been reported as a constituent of legume nodules by Hunt,<sup>5</sup> Virtanen and Miettinen,<sup>6</sup> and Bathurst.<sup>7</sup> Sen and Burma<sup>15</sup> did not find it in four legume species. Butler and Bathurst<sup>8</sup> reported that it did not occur in nodules of species of *Trifolium*, *Lotus*, *Pisum*, *Galega* and *Medicago*.

Glycine, alanine, valine, leucine, α-amino-butyric acid and γ-amino-butyric acid (neutral

fraction) were the next in importance in forming a high proportion (5.8 to 36.2%) of the nodular soluble nitrogen in most species studied here.

Aspartic, glutamic and  $\gamma$ -methylene glutamic acid (acidic fraction) and arginine, ornithine and histidine (basic) were distributed in lesser amounts except in *Arachis*, *Vigna* and *Clitoria*. Zelitsch *et al.*<sup>16</sup> have shown arginine, ammonia, glutamic acid, lysine and aspartic acid to be the most abundant compounds in the soluble portion of soyabean root nodules, while in those of lupin, Bathurst<sup>7</sup> observed aspartic acid and glutamic acid together with their amides, alanine, serine, histidine and valine to be the greatest in amount. Of the cyclic imino acids, proline was not observed in any, while pipecolic acid, reported by Steward,<sup>17</sup> to occur in *Phaseolus mungo*, comprised a small percentage in its nodules. In this species the quantity of serine was comparable to that of glutamic acid present.

$\gamma$ -Amino-butyric acid which may have an active role among free amino acids in nodules as a decarboxylation product and transamination partner of glutamic acid, and first reported by Okumuki,<sup>18</sup> later by Steward *et al.*,<sup>19</sup> and recently in *Trifolium repens* by Butler and Bathurst,<sup>8</sup> was observed in all legume nodules here with the exception of *Arachis* and *Centrosema*. Virtanen and Miettinen<sup>6</sup> who found chemically bound  $\gamma$ -amino-butyric acid in pea plants suggested that compounds of amino acids with sugars may be involved.

$\beta$ -Alanine, described by Virtanen *et al.*<sup>20</sup> as a decarboxylation product, occurred in fairly large quantity in nodules of *Dolichos* and *Vigna* while smaller amounts were found in others such as *Cyamopsis*.

Arginine, first suggested by Hunt<sup>5</sup> to occur in nodule extracts and subsequently observed to be one of the dominant compounds in soyabean nodules by Zelitsch *et al.*,<sup>16</sup> but not reported by Sen and Burma<sup>15</sup> was present in all legume nodules reported here with particularly large quantities in those of *Arachis*.

Phenylalanine, tryptophane and tyrosine were not observed in these legumes except the two species of *Dolichos*.

The variations in amino-acid content reported here might be a function of the species of plant examined<sup>21</sup> and may reflect the influence of host metabolism on symbiotic efficiency. The largest quantities of soluble nitrogen occurring

as the amide fraction in nodules together with their high haemoglobin content (239 to 835  $\mu\text{g./g.}$ —details to be published later) suggest high fixation levels. The quantitative preponderance of asparagine in the nodules of *Cyamopsis tetragonoloba* and of asparagine and glutamine in *Centrosema pubescens* in which the amide alone comprises 88.8 and 76.4% of the soluble nitrogen probably indicates high specific activity in fixation in these two tropical species. The role of these compounds as well as haemoglobin in the effectiveness of root nodules will be discussed in greater detail elsewhere.

I am grateful to Prof. T. S. Sadasivan for guidance and to Dr. L. Saraswathi-Devi for critical perusal of the manuscript. I thank the University of Madras and the Government of India for scholarships and the California Corporation for Biochemicals for kind supply of some amino-acids.

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# PETROLOGICAL INVESTIGATION OF TWO GONDWANA COAL SEAMS FROM MADHYA PRADESH, INDIA

S. K. BABU AND RUSSELL R. DUTCHER

Department of Geology and Geophysics, Organic Sediments Laboratory, The Pennsylvania State University,

THE basic petrographic composition of two seams (Seams # 2 and # 4) of lower Gondwana age,<sup>1,2</sup> collected from the Chirmiri colliery, Madhya Pradesh, has been determined. There is little published regarding the petrography of these coals. These seams are classed as "selected grade" following the coal grade classification employed in India. The present investigation employing a variety of research techniques was undertaken on these two seams, in order to determine the association of various macerals and the different coal components, to explain the physical and chemical properties of coal, to allow comparison with coals from the United States and to apply the information gained to future studies of other Indian Coals.

The studies carried out consist of the megascopic description of master columns; study of thin sections for maceral assessment; determination of maceral composition on polished pellets in reflected light; determination of mean maximum reflectance values on polished pellets; proximate analyses of selected petrographic zones; hot stage studies on vitrinoids to determine the thermal behaviour at various temperatures; electron microprobe studies of selected zones to determine the nature of the ash-forming elements present; analysis of certain zones petrographically important to determine the variation of total carbon and hydrogen and microhardness determinations on vitrinoids from 40 zones of the seams. A detailed paper embodying the results of these investigations will be presented at the American Coal Science Conference scheduled in June 1964, at The Pennsylvania State University.

Petrographically, these seams fall under the category of clarodurite and duroclarite. Seam # 2 is richer in vitrinoids than seam # 4, and relatively poor in fusinoids and micrinoids. It is reflected from the proximate analyses that the average ash content in both seams is 12%; the minimum encountered even in the best seams of Gondwana age. The variations in

fixed carbon, volatile matter, moisture, ash and sulphur of both seams are as follows:

	Seam #2 (%)	Seam #4 (%)
Fixed carbon ..	44.50-48.98	45.58-59.82
Volatile matter ..	34.88-41.8	24.80-41.40
Ash ..	8.04-16.88	8.80-18.96
Moisture ..	2.07-9.47	1.27-10.01
Sulphur ..	0.44-1.70	0.20-2.68

Petrographic composition and reflectance values are as follows:

	Seam #2 (%)	Seam #4 (%)
Vitrinoids ..	46.35-70.69	15.60-62.00
Fusinoids ..	4.46-21.78	0.50-44.40
Micrinoids ..	4.49-13.39	6.50-21.20
Exinoids ..	12.15-22.84	12.40-46.40
Resinoids ..	1.08-5.53	0.03-7.40
Mineral matter ..	2.68-4.82	1.80-12.90
Reflectance ..	0.555-0.696	0.520-0.746

The results indicate that these two coal seams differ considerably in their petrography and chemistry from the major coals of the United States but show a close affinity with the coals of Africa described by Hall<sup>3</sup> and coals from Australia described by Marshall.<sup>4</sup> Some of these differences and pertinent conclusions are summarized as follows:

1. The two seams from India fall under the category of high to medium volatile coals, rich in inertinoids, exinoids and poor in vitrinoids, as opposed to volatile-rich coals high in vitrinoids, exinoids and poor in inertinoids;

2. The vitrinoids present in the two seams of India are types V<sub>4</sub>, V<sub>5</sub>, V<sub>6</sub>, V<sub>7</sub>, V<sub>8</sub> of low reflectance value as contrasted with the V<sub>9</sub>, V<sub>10</sub>, V<sub>11</sub>, V<sub>12</sub>, V<sub>13</sub>, V<sub>14</sub> types of high reflectance value for American coals of good coking quality;

3. The two seams are high in ash content but low in sulphur in comparison to low ash and high sulphur values for many American coals;

4. These two seams from India are of a non-fluid type even at temperatures in excess of

600° C. In this respect they have a similarity with the coals from South Africa and Australia which are of non-fluid types.

The two seams are characterized by macerals of varying types; for example, vitrinoids of yellow, red or reddish-brown colour with or without structure; fusinite with large cells and small cells; micrinite of massive and fine-grained varieties which points to the heterogeneity of organic debris forming the macerals, and to changes in environments during the formation of the coal swamp consistent with the "drift" theory of origin for Gondwana coals.

low percentage of exinoids, and a high ash content. The transition stages of massive micrinite are very pronounced, and the granular micrinite so characteristic of coals of the United States is scarce. Further, the gradual transition from vitrinoids to semi-fusinite is very frequent.

These petrographic properties perhaps could be explained by differences in climate and vegetation when compared with coals of the United States of *in situ* origin. The differences can be better accounted for, however, by envisaging different conditions of origin for these coals from India, namely, a drift origin.

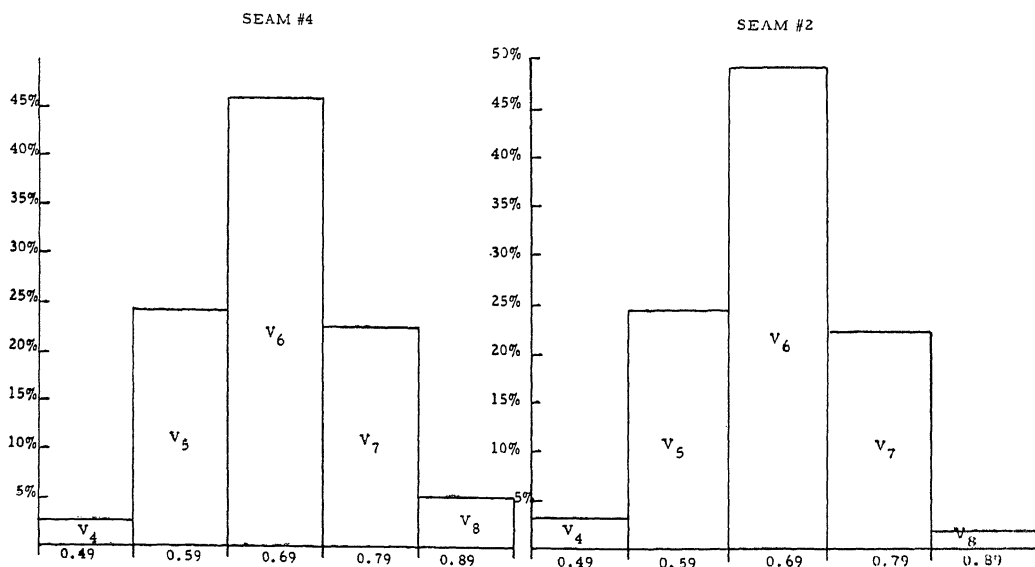


FIG. 1. Histograms showing the distribution of vitrinoids classified according to reflectance values in oil immersion

The petrography of the coal clearly points to the fact that the metamorphic conditions affecting the rank of both the seams were the same, as indicated by the distribution of the vitrinoid types of varying values of reflectance in the histogram presented as Fig. 1.

The variation in petrographic composition is very pronounced in these two seams of Gondwana age as compared to the carboniferous coals of the United States. These two seams are characterized by a wide variation in the percentage of vitrinoids and inerts, relatively

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## LETTERS TO THE EDITOR

### TOTAL ELECTRON CONTENT DETERMINATIONS USING TRANSMISSIONS FROM SATELLITE 1962 UPSILON-1 AT HYDERABAD, INDIA

RADIO TRANSMISSIONS from 1962 Upsilon-1 (Russian Satellite Cosmos-V) were recorded during the period October 1962 to February 1963 at the Defence Electronics Research Laboratory, Hyderabad, to determine the total electron content of the ionosphere. Recording was done for about 60 passes and out of these about thirty records were rejected as they were suspected to be affected by interference. This note embodies the results of analysis of some of the good recordings that were obtained.

The integrated electron content is given by the equation<sup>1</sup>:

$$\int Ndh = \frac{Zf^2\dot{\Omega}}{K_1 H_x V_x}$$

where  $\int Ndh$  stands for the number of electrons in a column of one meter square extending from satellite height to the receiver and  $\dot{\Omega}$  is the rate of Faraday rotation,  $K_1$  is a constant equal to 0.297.  $Z$  is the altitude of satellite in meters and  $f$  is the radio frequency in CPS.  $V_x$  is the horizontal component of satellite velocity at satellite altitude and  $H_x$  stands for the component of earth's magnetic field in the direction of  $V_x$ . This formula has been derived under the idealised assumptions, such as, horizontally moving satellite, horizontally stratified ionosphere, plane earth, etc. The error arising out of the departures from these idealised assumptions is less than the regular and sporadic variations in electron content and therefore the method based on the above formula is taken as being satisfactory for the preliminary analysis of Faraday Rotation Records.

In the present analysis, the rate of Faraday Rotation was calculated by determining the total rotations in a finite interval of time. The altitude of the satellite and the horizontal component of the satellite velocity were calculated from the orbital data.  $H_x$  was calculated from the surface values of magnetic field for the year 1962. These values were obtained by cor-

recting the surface values given by Vestine *et al.*<sup>2</sup> for the epoch of 1945.

The results of analysis of eight good passes that were recorded during the period 23-10-1962 to 15-2-1963 are shown in Fig. 1. For these

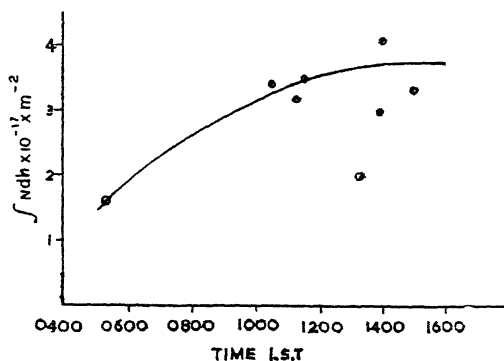


FIG. 1

passes the altitude of the satellite lies between 500 and 1,100 Km. It will be seen that as the time of recording varies from 0500 hours to 1500 hours the  $\int Ndh$  varies from  $1.0 \times 10^{17}/\text{m}^2$  to about  $3.5 \times 10^{17}/\text{m}^2$ . Somayajulu *et al.*<sup>3</sup> have carried out similar studies at Delhi using transmissions from the same satellite near about the same period. They reported that as the time of recording varies from 0400 to 1400 hours the  $\int Ndh$  varies from  $0.36 \times 10^{17}/\text{m}^2$  to  $3.46 \times 10^{17}/\text{m}^2$ . Thus the results are in reasonable agreement.

Propagation Division,  
Defence Electronics  
Research Laboratory,  
Hyderabad-5 (S. India),  
June 26, 1964.

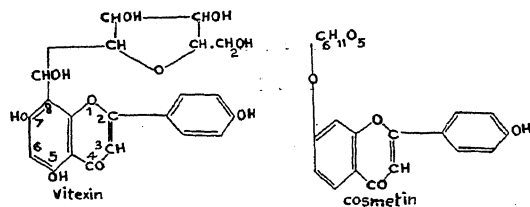
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C. RAMA RAO.  
G. C. SUBBA RAJU.

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## THE REAL NATURE OF TAMARIND ANTHOXANTHINS

In an earlier report<sup>1</sup> we concluded that the anthoxanthin pigments of tamarind (Bands I and II—glycosides), although closely resembling glycosides of apigenin and luteolin, are difficult to identify because of their poor hydrolysability by acids. Some flavone glycosides like the glucuronides have been reported<sup>2</sup> to be unusually resistant to acid hydrolysis. They are, however, easily hydrolysed by suitable enzymes. The pigments of tamarind were found to be unaffected by prolonged treatment with such enzymes:  $\beta$ -glucuronidase,  $\beta$ -glucosidase or anthocyanase.

It was suggested<sup>1</sup> that the tamarind pigments may be C-glycosides which are also known to be resistant to acid hydrolysis. Besides barbaloin, mangiferin,<sup>3</sup> vitexin<sup>4</sup> and lutexin<sup>5</sup> have been conclusively proved to be C-glycosides, where the sugar residue is attached to the pigment nucleus by a C-C bond instead of a C-O-C bond present in ordinary glycosides:



8-C glucoside of  
apigenin

Apigenin-7-glucoside

On treatment with boiling HI in phenol (conditions used for hydrolysing the C-C link in mangiferin<sup>3</sup>), the tamarind flavones yielded apigenin and luteolin, identified by chromatography and colour reactions. Oxidation with  $\text{FeCl}_3$  gave some glucose, identified by chromatography and osazone formation. That they are flavone C-glycosides follows from their resistance to acid hydrolysis. Hence, they were suspected to be vitexin and lutexin, the 8-C-glucosides of apigenin and luteolin respectively. Co-chromatography of the pigments with vitexin and lutexin in four solvent systems showed them to be identical to the authentic specimens. The melting points reported before<sup>1</sup>—257° and 263° for the two glycosides—agree with those for lutexin 255–57°, and vitexin 260–64°. This finding fits in with the taxonomic position of *Tamarindus indica* since flavone C-glycosides have been isolated from several genera in the Leguminosae.

We are deeply indebted to Dr. J. B. Harborne of John Innes Institute, England, for much of the experimental evidence given here.

Central Food Technological  
Research Institute,  
Mysore-2, May 11, 1964.

Y. S. LEWIS.  
S. NEELAKANTAN.

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## ENZYMES IN FIVE NON-ALLELIC RIBOFLAVINLESS MUTANTS OF *ASPERGILLUS NIDULANS*

THE biochemical and genetic study of five non-allelic riboflavinless mutants of *Aspergillus nidulans*, isolated at the Department of Genetics, Glasgow University, Scotland, by ultra-violet irradiation,<sup>1</sup> is being carried out in the Madras University laboratory. The mutants *ribo*<sub>1</sub> and *ribo*<sub>2</sub> are located in the first and eighth chromosomes respectively,<sup>2</sup> whereas, the mutants *ribo*<sub>3</sub> and *ribo*<sub>5</sub> map in the fifth, and *ribo*<sub>6</sub> in the second chromosome. All these mutants have been found to be temperature independent.<sup>3</sup> In *N. crassa* only two riboflavinless mutants have been so far reported, one temperature dependent<sup>4</sup> and the other temperature independent.<sup>5</sup> In the case of the temperature-dependent mutant, the enzyme changes which occurred with optimal or deficient concentrations of riboflavin have been worked out by Nicholas.<sup>6</sup> Based on the work of Nicholas, an attempt had been made to compare the enzyme changes in the five temperature-independent non-allelic riboflavinless mutants of *Aspergillus nidulans*.

The enzymes assayed were catalase, peroxidase, hexokinase, phosphorylase and alkaline phosphatase. The mutant was grown on the liquid medium having the following composition per litre, the pH being adjusted to 6.5;  $\text{KH}_2\text{PO}_4$ —1.52 gm.,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ —0.52 gm.,  $\text{KCl}$ —0.52 gm.,  $\text{NaNO}_3$ —6.00 gm., Glucose—20.00 gm., and traces of zinc and iron.

The mycelia were harvested after seven days of growth and homogenised with suitable buffers for the assay of the enzymes. Catalase was assayed by the method of Feinstein.<sup>7</sup> Sodium perborate was used as the substrate and the perborate remaining after catalase action was titrated with potassium permanganate in the presence of sulphuric acid. The method of

Smith and Stotz<sup>8</sup> was used for estimating peroxidase activity. The activity depends upon the formation of purpurogallin which was formed by the action of peroxidase upon pyrogallol. The activity of hexokinase was measured by the method of Kunitz and McDonald.<sup>9</sup> The method of Whelan<sup>10</sup> was used for the assay of phosphorylase. Starch and glucose-1-phosphate were mixed with the enzyme, and the orthophosphate set free during amylose synthesis was measured colorimetrically. The activity of alkaline phosphatase was determined by the method of Bessey, Lowrey and Brock<sup>11</sup> in which the breakdown of *p*-nitrophenyl phosphate to *p*-nitrophenol was measured.

In the case of each mutant two conditions were tested, one grown with optimal concentration of the vitamin riboflavin, the concentration being 15 micrograms per 25 ml. of the medium, and the other with deficient concentration of riboflavin, the concentration being 3 micrograms per 25 ml. of the medium.

appreciable change in the enzyme activity between the normal mycelia and the riboflavin-deficient mycelia. In all the mutants the two types of mycelia show more or less the same activity. On the other hand, peroxidase activity increases in the riboflavin-deficient mycelia in all the mutants. The amount of the enzyme activity in the various mutants is in the order  $\text{ribo}_3 > \text{ribo}_6 > \text{ribo}_5 > \text{ribo}_1 > \text{ribo}_2$ .

In regard to hexokinase activity, there is a great increase in the riboflavin-deficient mycelia of all the mutants and nearly a hundredfold increase is noticed in  $\text{ribo}_2$ ,  $\text{ribo}_1$  and  $\text{ribo}_6$ , and the activity is in the order  $\text{ribo}_2 > \text{ribo}_1 > \text{ribo}_6 > \text{ribo}_5 > \text{ribo}_3$ . However, phosphorylase activity increases in the riboflavin-deficient mycelia only in  $\text{ribo}_1$  and  $\text{ribo}_2$ , and there is no change in other mutants. It is interesting to see that, in the case of alkaline phosphatase, there is a decrease in enzyme activity in the mycelia of  $\text{ribo}_3$ , and an appreciable rise in the activity in the case of  $\text{ribo}_1$  and  $\text{ribo}_2$ .

TABLE I

Enzyme activity in various riboflavinless mutants and the wild strain of *Aspergillus nidulans*

Unit of enzyme activity is expressed per 100 mg. of total nitrogen.  
Results represent average of five independent estimations.

Enzyme	ribo <sub>1</sub>		ribo <sub>2</sub>		ribo <sub>3</sub>		ribo <sub>5</sub>		ribo <sub>6</sub>		Wild Strain
	ribo <sub>1</sub>	% increase	ribo <sub>2</sub>	% increase	ribo <sub>3</sub>	% increase	ribo <sub>5</sub>	% increase	ribo <sub>6</sub>	% increase	
Catalase	(a) 0.1892	Negligible	0.1848	3	0.1892	1	0.1896	1	0.1897	Negligible	0.3209
	(b) 0.1902		0.1896		0.1917		0.1909		0.1900		
Peroxidase	(a) 3.8640	10	4.0520	7	4.5610	25	3.7090	16	3.7610	17	5.5990
	(b) 4.2570		4.3410		5.6930		4.3140		4.4030		
Hexokinase	(a) 152.8	90	126.6	119	77.8	28	185.0	67	156.6	85	299.80
	(b) 290.1		276.7		99.82		308.7		290.2		
Phosphorylase	(a) 177.6	16	155.4	38	153.4	13	165.6	3	153.4	5	165.70
	(b) 205.2		214.3		172.9		170.5		160.3		
Alkaline phosphatase	(a) 1.120	17	1.192	11	1.465	Decrease	1.391	5	1.349	4	1.135
	(b) 1.315		1.318		1.174		1.463		1.401		

(a) Mutant grown with optimal concentration of riboflavin, the concentration being 15 micrograms per 25 ml. of the medium. (b) Mutant grown with deficient concentration of riboflavin, the concentration being 3 micrograms per 25 ml. of the medium.

The results of assays of enzymes in five non-allelic riboflavinless mutants of *A. nidulans* are presented in Table I. It can be seen from the table that in the case of catalase there is no

Comparing the results of enzyme assays in *A. nidulans* with those of Nicholas in *N. crassa*, it is found that, peroxidase and hexokinase activities rise to a high extent in both *A. nidulans*

and *N. crassa*. According to Nicholas, the percentage increase in hexokinase activity in riboflavin-deficient mycelia is 30 in *N. crassa*. However, the present work on *A. nidulans* shows that, the maximum percentage increase of hexokinase activity in the riboflavin-deficient mycelia is four times as observed by him. The peroxidase activity is too high in the riboflavin-deficient mycelia of *N. crassa*, whereas, in the mutants of *A. nidulans*, the increase in activity is only one-fourth as present in *N. crassa*. Also, according to Nicholas, catalase activity of *N. crassa* is slightly decreased in riboflavin-deficient mycelia which is not so in the case of *A. nidulans*. In experiments of Nicholas, there are no differences in the values of phosphorylase and alkaline phosphatase between the normal and riboflavin-deficient mycelia. However, in the present investigation, there are appreciable differences between the two types of mycelia in the case of phosphorylase and alkaline phosphatase.

The values of the activities of the various enzymes which are present in the wild strain of *A. nidulans* are shown in Table I. Comparing the values of the mutants with that of the wild strain, it is possible to note that catalase activity is nearly double in the wild strain than in the mutants. There is not much difference between the activity of peroxidase in the wild strain and in the mutants. Hexokinase activity is far more in the wild strain than in the normal mycelia of the mutants. However, in the case of the wild strain and the mutants, the values for phosphorylase and alkaline phosphatase are alike. Hence, a conclusion can be drawn from this comparison that when the mutants are supplied with optimal concentration of riboflavin, they behave more or less like the wild strain in only certain cases.

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Univ. Biochem. A. S. KANAGASABAPATHY.

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## STUDIES IN *CASSIA FISTULA* LINN. LEAVES

THE use of the pods and leaves of some *Cassia* species extends back to ancient periods. The purgative activity of these drugs has recently been attributed mainly to the presence of glycosides of 1 : 8-dihydroxyanthraquinone derivatives.<sup>1,2</sup> However, the exact nature of the glycosides present in different species is still under investigation in several laboratories. Major part of the latter work deals with the officially recognised drugs, viz., leaves and pods of *Cassia angustifolia* Vahl, and *Cassia acutifolia* Delile. In the general move of the medical practice towards the use of pure isolated sennosides have come on the market, and for the supply of active glycosides one may not look to the official drugs only. Others, whose extracts or tinctures could not be used as such might become good sources of the active glycosides. Leaves of *Cassia fistula* Linn. could be cited as an example. A preliminary study of these leaves is reported here.

For this purpose a neutral aqueous extract of the leaves of *Cassia fistula* Linn. was fractionated by precipitation with acid. The acid precipitates which showed the presence of a glycoside was freed of resin, fats, free anthraquinones, etc., and the residue was extracted with ethanol. The ethanolic solution after removal of solvent was hydrolysed with 3N acid by heating on a boiling water-bath for 15 minutes. The hydrolysate was extracted with ether and both, the ether extract and the residual aqueous extract, were chromatographed with different solvent systems. Chromatography and cochromatography showed that while the ether extract contained rhein, the residual aqueous hydrolysate contained glucose. The latter was absent before hydrolysis.

The filtrate from the acid precipitates was neutralised and the other glycosides were precipitated as calcium salts with alcohol. The mixture of calcium salts was decomposed with oxalic acid and the liberated glucosides after being purified through methanol were partitioned between the layers formed by mixing methanol, ethyl acetate and water. The glycosides further purified through acetone were

finally identified as sennoside A and sennoside B, by cochromatographic techniques.

Purification of the neutral aqueous extract by the lead salt precipitation method has also given similar results. Preliminary studies have indicated seasonal variation in glycosidal content of the leaves. Further work is in progress.

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### CONSTANCY OF CATION EXCHANGE CAPACITY OF PLANT ROOTS

As compared to studies of cation exchange capacities of soils, those on cation exchange capacity in plant roots are of recent origin. While the cation exchange capacity (C.E.C.) of soils is nearly constant under a large number of conditions, the knowledge about C.E.C. of plant roots under different conditions is not as complete.

Mclean *et al.* (1956) and Smith and Wallace (1956) have reported that nitrogen content and cation exchange capacity of plant roots increase with nitrogen treatment. Wander and Sites (1956) have noted that the C.E.C. of plant roots was more in the case of  $\text{NO}_3$ -Nitrogen treatment than in the  $\text{NH}_4$ -Nitrogen treatment. The purpose of the present investigation is to see the effect of varying calcium-potassium ratio or phosphorus in the culture solution on the C.E.C. of plant roots of some crop plants grown in sand culture.

*Triticum aestivum* (wheat) New Pusa 718, *Oryza sativa* (paddy) New Pusa 130, *Nicotiana tabacum* (tobacco) Harrison special, *Zea mays* (maize) Kanpur type 41, and *Phaseolus aureus* Roxb. (mung) Lucknow type were grown in quartz sand using Hewitt's (1952) culture solution. At the flowering stage the plants were removed with roots intact without being damaged during the process and excess soluble salts and sand particles were removed by washing with distilled water. The excised plant roots were dried in the oven at 60° C. and powdered. 0.5 gm. of the composite sample in triplicate was taken for analysis. The cation exchange capacity was determined by the method followed by Jain (1959). In short, the root samples were saturated first with dilute HCl (0.05 N) and then  $\text{H}^+$  ion was replaced with 0.2 N calcium acetate solution. After

removing excess soluble calcium salt with distilled water, adsorbed calcium on the root surface was displaced by dilute HCl (0.05 N) and estimated by standard versenate solution and expressed in m.e./100 gm. of dried material.

TABLE I  
Cation exchange capacity of plant roots under varying potassium-calcium treatments  
(Expressed in m.e./100 gm. of dry wt.)

Treatment (Conc. in m.e./l.)		Crops				
K	Ca	Paddy	Maize	Wheat	Tobacco	Mung
4	6	..	14.6	9.3	50.3	35.8
2	8	14.2	14.3	9.2	49.4	35.5
1	9	..	14.6	9.2	49.6	35.4
0.5	9.5	..	14.4	9.3	49.4	35.5
0.25	9.75	..	14.6	9.1	49.3	35.3

TABLE II  
Cation exchange capacity of plant roots under varying phosphorus treatment  
(Expressed in m.e./100 gm. of dry material)

Treatment* (Atoms./l. $\times 10^{-4}$ )		Crops			
A	B	Wheat	Paddy	Tobacco	Mung
13.8	9.3	12.0	14.4	41.6	36.2
6.1	3.3	12.0	13.7	40.8	36.0
4.6	1.5	10.8	12.7	40.0	36.0
1.5	0.8	10.8	13.5	40.0	35.8
0.8	0.3	10.8	13.1	39.2	35.9

\* Treatment A for paddy and B for other crops.

The results of Table I show that the variation in cation exchange capacity of wheat, tobacco, maize and mung roots under different potassium-calcium ratios is not more than 2% from the mean value. The same conclusion regarding the effect of phosphorus treatment can be derived for the cation exchange capacity of paddy, tobacco and maize from Table II. However there is some difference for the cation exchange capacity value for the tobacco and wheat for the potassium-calcium and phosphorus treatments. These variations are however not much in view of the nature of the material under study. The values of C.E.C. of wheat, maize and paddy being monocot are much less than those of tobacco and mung which are dicot and are in conformity with those of Mehlich and Drake (1955). Huffaker and Wallace (1959) have also studied the effect of phosphorus treatment on C.E.C. of soyabean, rough lemon and corn but their data do not lead to any conclusion. The above results suggest that the factors responsible

for the cation exchange capacity of plant roots do not seem to be affected much by varying potassium-calcium and phosphorus in the range studied.

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### SURVEY OF ALGIN-BEARING SEAWEED AT ADATRA REEF, OKHA

THE brown seaweed, *Sargassum*, has in recent times assumed commercial importance since alginic acid and mannitol are being produced from it, also in India. The average yield of alginic acid from *Sargassum tenerrimum* J. Ag., available at Adatra reef, is about 8% on dry basis. With a view to assess the dense growth of this economic seaweed at Adatra, a survey was carried out from mid-December 1961 to mid-December 1962.

Adatra reef is in the latitude 22° 29' N. The reef is of limestone and its surface is very rugged. It is situated 2 miles south-west of Okha Port. The reef slopes gradually and has a width of 200 m. and length of 440 m. It faces east and is protected by a group of islands. In the hinterland there are sand-dunes. There are very large tide pools in the mid-littoral and also gully-like streams running from mid-littoral to low littoral.

*Sargassum* forms rich, dominant growths in the tide pools and in the sub-littoral. During low tides the depth of water in the tide pools is about 0.45 m. In the sub-littoral the growth is present down to a depth of 0.9 m. measured at low tide. The reef shows a layer of fine silt, mixed with sand, covering the limestone. During the season of rapid growth the water

temperature is about 18° to 24° C. in the day-time.

After the rains of the south-west monsoon, that is in early September, the plants come up in quantity from the persistent holdfasts and from the germlings. It was found that there is very rapid growth of *Sargassum*, during the winter months of November and December, the plants attaining heights of 0.9-1.7 m. during this period. Good amounts of *Sargassum* are uprooted and cast up on the shore in January. Towards the end of January or early part of February, *Sargassum* begins to die away as seen from large-scale shedding of leaves and bladders. Thus there is a short season of availability of the mature plants, of *Sargassum*, extending from November to January.

Sampling at depths of 0.3-0.9 m. was done along transects from the shore to the sub-littoral, with a metre-square quadrat. In greater depths sampling was not possible due to inaccessibility. Samples were taken during favourable low tides, on the stated dates. Seaweed density and cover were calculated by the method of Walker.<sup>2</sup> The results are shown in Table I. The seaweed density is given as the average weight of weed per sq. meter. Algal "cover" is defined as the number of sampling operations with weed expressed as a percentage of the total number of sampling operations.

During January 1962 the plants of *Sargassum* were loaded with epiphytes, chiefly *Nemacystus decipiens*, which fact partly accounts for the increase in estimated weight in January 1962 over that in December 1961. The decrease noticed in February 1962 is brought about by the decline in crop caused by the commencement of decay and shedding of leaves (Table I).

TABLE I  
Calculated total seaweed at Adatra

Date of survey	Total weight (fresh) Kg.	Total area (Sq. M.)	Density Kg./m. <sup>2</sup>	Cover %
2-12-1961	60,000	15,000	4	60
4-1-1962	90,000	15,000	6	80
4-2-1962	30,000	15,000	2	40
10-12-1962	54,600	15,600	3.5	71

The only attempt to ascertain Indian resources in *Sargassum* is that of Hornell,<sup>1</sup> who has provided the figure of 100 tons, for the fresh *Sargassum* cast up per year along the 40 km. Okhamandal coast of Gujarat, i.e., from Kuranga to Okha (including Adatra). In the present survey the quantity of fresh *Sargassum* available

in 15,000 sq. m. of the Adatra reef was found to be 60 metric tons per year. Since Adatra reef is only 0.44 km. in length it appears that the quantities available on the Okhamandal coast are greater than 100 tons given by Hornell's survey which took into account only the washed-up *Sargassum*.

The authors wish to express their thanks to Dr. D. S. Datar for his keen interest in this study.

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## A PRELIMINARY INVESTIGATION ON THE PALEOMAGNETIC DIRECTIONS OF THE CHARNOCKITES OF ANDHRA PRADESH

CHARNOCKITE and Charnockite series of rocks describe a group of rocks varying in composition from acidic to ultrabasic rocks characterised by the presence of orthopyroxene and by a general similarity in colour and texture (Krishnan, 1960). A lot of geological literature has grown on the petrology of the charnockite series and it is not yet clear whether these rocks are igneous or metamorphic. Doubts have been expressed whether the so-called 'charnockite series' of rocks comprising the acidic, intermediate and basic divisions belong to the same petrological group or whether they represent entirely different rocks not genetically connected with each other. The charnockites belong to the Archean group of the Indian rocks (probably about 1,500 M Y). Recent work (Aswathanarayana, 1964) by radioactive dating techniques showed the age of metamorphism and uplift of the charnockites (from Kondapalle, and from Visakhapatnam, Andhra Pradesh) to be around 500 M Y and the age of their original emplacement to be around 1,300 to 1,520 M Y.

In September 1962, about 12 oriented samples of charnockites from Visakhapatnam and 7 oriented samples from Kondapalle, Krishna District (Andhra Pradesh), have been collected and their paleomagnetic directions have been measured with an astatic magnetometer at the Imperial College, London. The magnetic stability of the samples has been tested by heating the oriented cylinders under astatic magnetometer and observing their magnetic moment in three perpendicular directions as has

been described by Wilson (1961), the consistency of the direction of the magnetic vectors being taken as a measure of the magnetic stability of the samples.

In Figs. 1 and 2 are plotted the paleomagnetic directions of the Visakhapatnam and Kondapalle charnockites respectively, on a Schmidt's equal

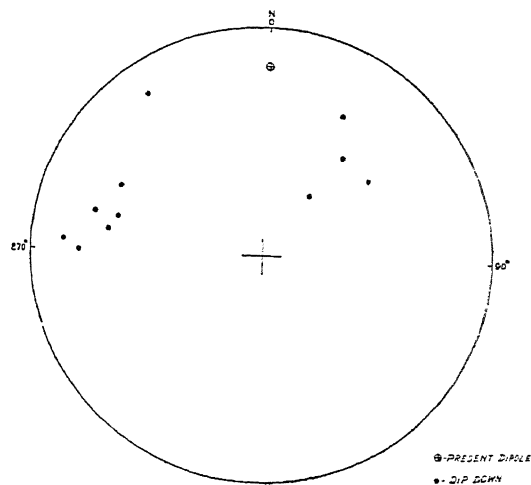


FIG. 1. Visakhapatnam Charnockites. Equal area projection.

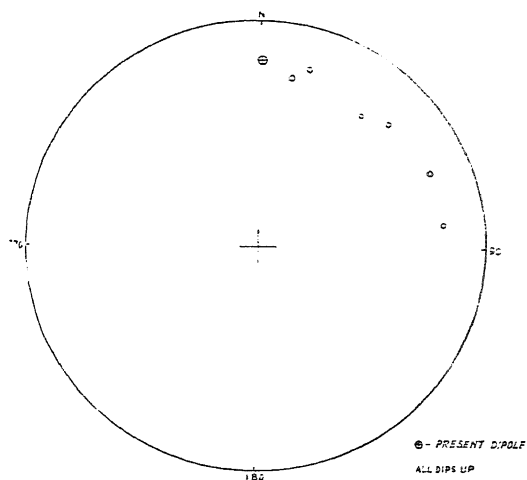


FIG. 2. Kondapalle Charnockites. Equal area projection.

area projection. Two definite groups of directions are present among the Visakhapatnam charnockites, six of the samples showing a mean direction of 280° E. in declination and 35° Down in inclination and four of the samples showing a mean direction of 45° E. in declination and 45° Down in inclination. The paleomagnetic

directions of Kondapalle charnockites are widely scattered in declination, ranging from  $10^{\circ}$  E. to  $90^{\circ}$  E., but show a consistent dip of about  $20^{\circ}$  up. Except for a couple of samples whose magnetic direction changed abnormally with temperature while testing for their magnetic stability as described above, the rest of the samples are magnetically stable. In the above figures are plotted only the consistent magnetic directions of the samples after the secondary magnetic effects are removed by heating up to  $100^{\circ}$  to  $150^{\circ}$  C. The two abnormal samples mentioned are omitted in the figures.

The downward dips of  $35^{\circ}$  and  $45^{\circ}$  Down for the two groups of rocks, from Visakhapatnam, correspond to the latitudes of  $19^{\circ}$  and  $27^{\circ}$  respectively in the northern hemisphere. Since the Indian subcontinent in the Archean times when these rocks are formed, is assumed to have been in the southern latitudes, both from the geological evidence and from paleomagnetic data on other Indian rocks, we have probably to assume that the charnockites from Visakhapatnam are reversely magnetised. Their normal declinations in that case would be  $100^{\circ}$  E. and  $225^{\circ}$  E. for the two groups, and the Indian land mass must have rotated anticlockwise by about  $260^{\circ}$  and  $135^{\circ}$  respectively since these rocks are formed. Such a great rotation appears not only inconceivable by itself, but also from the consideration of the directions of the Deccan traps of India. For Rajmahal traps with an approximate age of 150 M Y the inclinations obtained are around  $63^{\circ}$  (Clegg *et al.*, 1958), while the present rocks possess shallower dips corresponding to much lower ancient latitudes. In the case of the Kondapalle charnockites also the dip of  $20^{\circ}$  up is very much shallower compared to the Deccan traps.

On the other hand the rocks might have lost their original magnetisation and remagnetised in more recent epochs. Further, these rocks might have been subjected to tilts, uplifts and other various geological disturbances (Krishnan, 1960) since they were magnetised. Because of the notorious complexities involved in the magnetic directions of the metamorphic rocks, the problem needs much further study.

I am grateful to Prof. P. M. S. Blackett in whose laboratory the above measurements have been carried out. My thanks are due to Prof. M. S. Krishnan for his advice on the geological aspects of the work.

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### THE EFFECT OF TEMPERATURE ON THE FELSPARS OF THE CHARNOCKITE SERIES

THE charnockite series of rocks of Visakhapatnam are mainly of two types—the acid division comprising charnockite and garnetiferous charnockite, and the basic division comprising gabbro, norite, hornblende norite, biotite norite and amphibolite. Plagioclase feldspar is present in the rocks of both the divisions whereas perthitic feldspar is present only in the acid division.

In an outcrop ( $17^{\circ} 43' 15''$  N. and  $83^{\circ} 20'$  E.), a big feldspathic segregation is noticed in the charnockite. The feldspar is exclusively orthoclase perthite which is dark grey in colour. Big crystals of perthite measuring up to 5 to 6 inches have been obtained from this segregated patch. The plagioclase feldspar was separated from basic charnockite, while perthite and plagioclase feldspars together with quartz were obtained from the acid members. The natural colours are—perthite is dark grey, plagioclase is greyish-white and the quartz is light grey.

The feldspars and quartz were heated in a muffle furnace, which has a range up to  $1000^{\circ}$  C. The temperature was increased in steps of  $50^{\circ}$  C. and the changes in the products noted. Practically no change was observed till  $450^{\circ}$  C. even when heated for 12 hours. The plagioclase (from gabbro) turned pink when heated for 4 hours at  $500^{\circ}$  C., and remained so even when heated for 12 hours. The perthite (crystal) changed its colour to pink at  $550^{\circ}$  C. when heated for 12 hours and the same effect was noted when heated at  $600^{\circ}$  C. for 3 hours. The colour change started along the cleavage planes and extended to the whole mass. The perthite was examined under the microscope after it was heated and it was found that the plagioclase feldspar phase had dwindled owing to homogenisation. The perthite, plagioclase and quartz when heated together for 3 hours in a porcelain crucible became pink at  $600^{\circ}$  C. Small pieces of charnockite and gabbro were heated for 3 hours at  $600^{\circ}$  C. The charnockite turned pink and no conspicuous change was observed in the gabbro,



In order to know what elements are responsible for the coloration of the minerals and the change of colours when heated, perthite and plagioclase were analysed for certain constituents. Iron is present in the ferrous and ferric states in both the minerals.  $\text{Fe}_2\text{O}_3$  is 0.45% and 0.37% and  $\text{FeO}$  is 0.23% and 0.28% in plagioclase and perthite respectively. Qualitative tests have not revealed the presence of manganese and titanium, but the spectrochemical analysis revealed their presence. Both the minerals were leached with hydrochloric acid and when they were heated afterwards no pink coloration was observed. From this, it is obvious that iron is mainly responsible for the colour in the minerals and subsequent change when heated. Jayaraman<sup>1</sup> who examined the green and pink perthites of pegmatites came to a similar conclusion.

The analyses of feldspars of the charnockites of Madras by Howie<sup>2</sup> and Naidu<sup>3</sup> also show ferrous and ferric iron. The presence of ferric iron in feldspars has been explained by Rosenqvist,<sup>4</sup> Faust,<sup>5</sup> and Barth,<sup>6</sup> as due to replacement of  $\text{Al}_2\text{O}_3$  by  $\text{Fe}_2\text{O}_3$  in the lattice of potash and soda feldspars. But the presence of ferrous iron in the feldspars is not well understood.

The colour change first taking place along the cleavages of the feldspars may indicate that the iron is getting out of the lattice in the form of pink iron oxide. The homogenisation of perthitic feldspar around 600° C. may indicate that it has formed from temperatures higher than 600° C. by gradual cooling. This indicates that the charnockites containing these perthites originated in a high temperature environment.

The author expresses his thanks to Dr. A. Sriramadas for suggestions.

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# A NOTE ON MAGNETIC STUDY OF A DOLERITE DYKE NEAR AMARPUR, DHANBAD (BIHAR)

DURING the course of a geophysical survey in the neighbourhood of Dhanbad (23° 48' N. : 86° 24' E.), an unreported dolerite dyke, has been found, cutting Archean gneisses. The dyke strikes WNW-ESE. It is 50 feet wide and over 1 mile long, cutting the Grand Trunk Road at Amarpur village (23° 50' N. : 86° 31' E.).

Two types of basic dykes have been reported in and around Jharia coalfield by earlier workers: (1) dykes of Pre-Cambrian metabasic rocks<sup>1-3</sup> (mainly metadolerite and epidiorite) and (2) unmetamorphosed dolerite dykes,<sup>4</sup> occurring in the coal-bearing lower Gondwana formations of the Jharia coalfield, of post-L. Gondwana age (Jurassic, cretaceous or Tertiary). The two types differ in the mode of occurrence, petrography and age. Sadasivaiah<sup>4</sup> made a detailed petrographic study of the second type and confirmed Fox's<sup>5</sup> suggestion that they belong to the Deccan Trap period of igneous activity. Dykes of both types have been reported in the Archean gneisses by Sharma,<sup>6</sup> in the adjoining Kodarma Mica field.

The dolerites of this area differ from the metadolerites in their non-metamorphic character and absence of orthorhombic pyroxene. A petrographic description of metadolerite and epidiorite of a dyke in Dhanbad was given by the authors<sup>3</sup> earlier in a separate note. The dyke under description belongs to the second group.

Seven magnetic traverses were taken across half-a-mile length of the dyke, with Schmidt vertical force variometer. At places negative anomalies up to 1,600 gammas with respect to the local background were obtained. The direction of natural remanent magnetization was determined on unweathered, oriented samples, with an astatic magnetometer. They show steep negative magnetic dips (north pole upwards) and declinations west of north. The intensity of natural remanent magnetization is about  $4 \times 10^{-3}$  c.g.s. units, volume susceptibility about  $2 \times 10^{-3}$  c.g.s. units and Koenigsberger ratio about 4. The remanence is found to be quite stable. Thus, the strong negative vertical magnetic anomalies over the dyke can be explained in terms of reversed permanent magnetization of the rocks in the vertical direction.

The normal magnetization in the horizontal direction and reversed magnetization in the vertical direction show that these rocks acquired thermo-remanence in the normal geomagnetic

field in the southern hemisphere, supporting the idea that India was in the Southern hemisphere when the dykes cooled in Jurassic or Cretaceous period.

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Department of Geophysics, JAGDEO SINGH.  
Indian School of Mines, M. KRISHNA RAO.  
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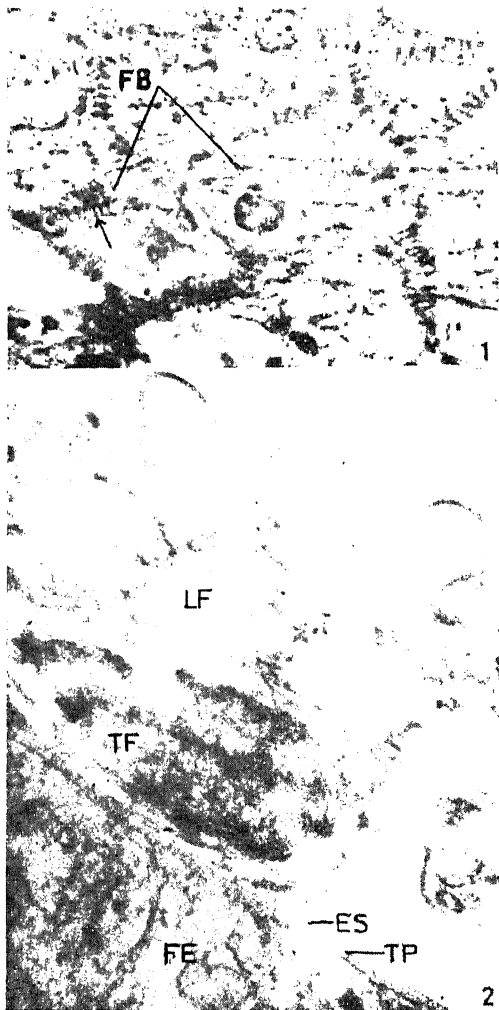
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#### OVARIAN SHEATHS OF THE SCORPION FLY, *PANORPA COMMUNIS* (MECOPTERA-INSECTA)

In insects two kinds of devices for pushing the ripe egg from the vitellarial follicles into the oviduct were reported. In a majority of insects there are well-defined striped muscle fibres in the external ovariole sheath (= peritoneal epithelium), which consequently becomes contractile and serves this purpose.<sup>1,2</sup> In the panoistic ovarioles of the cockroach, *Periplaneta americana* no muscular elements are present in the external ovariole sheath and the highly elastic, PAS-positive tunica propria (= basement membrane) compensates for the lack of muscles and it undergoes an increase in thickness corresponding to the growth of the oocyte.<sup>3,4</sup> A condition which differs from both these occurs in the meroistic-polytrophic ovarioles of the scorpion fly, *Panorpa communis*, which is considered to be a primitive member of the holometabola.

In *Panorpa*, the comb-shaped ovary on each side is contained in a loose network of common ovarian sheath which unites with the sheath of the opposite ovary and forms at the apex a common envelope for both the ovaries. The terminal filaments of the ovarioles of the opposite sides converge and unite into a median suspensory cord which is drawn into the head region. Each ovariole is enveloped by a second external ovariole sheath made up of flattened cells which rest on the tunica propria. The common ovarian sheath consists of distinctly nucleated, stellate cells whose irregular extensions coalesce and give rise to a network. In total preparations (flat spreads), these cell

extensions appear as hollow tubes with parallel running fibres inside. They show also regional transverse foldings which appear as close-fitting rings (Fig. 1). The internally laid fibrous



FIGS. 1-2. Fig. 1. Phase contrast photomicrograph of an unstained flat spread of the common ovarian sheath showing the network of stellate cells whose hollow extensions contain fibrous tissue within (→), × 960. FB = fibrous. Fig. 2. Electron microphotograph of a section through the common ovarian sheath showing striped muscles. The external ovariole sheath is reduced to an extremely thin membrane. Fixing and contrasting after Wolfarth-Bottgermann (*Naturwiss.*, **44**, 1957). × 16,000. FE = Follicle epithelium; TP = tunica propria; ES = external ovariole sheath; LF = muscle fibres cut longitudinally; TF = muscle fibres cut transversely.

tissue does not, however, exhibit in the light microscope any stripes. Under the electron microscope, these hollow cellular extensions are seen to contain distinct striped muscle fibres

which within the stellate cell cross each other and hence are cut longitudinally as well as transversely (Fig. 2).

Apart from these bundles of muscle fibres in the common ovarian sheath, no other muscularities are found in the external ovariole sheath of *Panorpa*. Also the tunica propria does not become thickened in the older oocytes as reported for *Periplaneta* but, on the other hand, it becomes distinctly thinner due to stretching which bears a relation to the transport of blood proteins into the oocyte.<sup>5</sup> Here the muscle fibres are localized in the common ovarian sheath which, therefore, exercise peristaltic contractions that spread over the entire ovary and squeeze all the ovarioles simultaneously. This mechanism may be considered as a more primitive type than those cases where each ovariole is provided individually with its own muscular sheath which enables it to undergo contractions independently. This feature is in accord with the view that the Mecoptera represent an archaic group from which the higher holometabola (Trichoptera, Lepidoptera and Diptera) are derived.<sup>6</sup> A comparative study is in progress.

Department of Zoology, P. S. RAMAMURTY.  
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# MORPHOMETRIC STUDIES ON THE ROTIFER BRACHIONUS CALYCIFLORUS PALLAS

I COLLECTED a number of rotifers from different localities of Rajasthan during 1961-63. Apparently *Brachionus calyciflorus* Pallas has been found to be an extremely variable species. Morphometric study of *B. calyciflorus* has earlier been done mainly in connection with its cyclo-morphosis.<sup>1-3</sup> An attempt is made here to study the nature and extent of variation of the rotifer collected from different localities.

Collections have been made from six places in Rajasthan, viz., Pilani, Amer (Jaipur), Nakki Lake (Mount Abu), Ajit sagar (Khetri), Gajner (Bikaner) and Swarup sagar (Udaipur). In Pilani they were collected from a small pond while other samples were collected from lakes. Tow net made of nylon cloth has been used for

the collection. Hundred specimens were measured from the sample from Pilani and 25 from each of the other samples. Measurements were not made for the specimens from Udaipur owing to inadequate number of specimens obtained in the sample.

It has been found that the specimens from Khetri have got the maximum length of the lorica (Table I). Their length varied from 317 to 362  $\mu$  and 60% of the individuals were having a mean length of 347  $\mu$ . The specimens from Bikaner showed a variation from 182 to 277  $\mu$ , that of Jaipur and Mt. Abu from 167 to 242  $\mu$  and that of Pilani from 154 to 226  $\mu$ . Out of all the five samples the specimens from Khetri showed the minimum range of variability.

TABLE I  
Variation in the dimensions of *B. calyciflorus*

Locality	Mean length	Mean width	Left post. spine	Rt. post. spine
Khetri ..	340 $\mu$	247.4 $\mu$	34.72 $\mu$	19 $\mu$
Bikaner ..	228	190	52	47.2
Jaipur ..	213.2	186.7	0	0
Mt. Abu ..	210	160	18.1	12.8
Pilani ..	181.2	147.7	10.4	3.8

Maximum width has been shown by the specimens from Khetri with a range of variation from 210 to 277  $\mu$ . The smallest width has been shown by the specimens from Pilani with a range of variation from 120 to 164  $\mu$ . The specimens from Jaipur and Mt. Abu showed a range of variation from 170 to 203  $\mu$  and 130 to 185  $\mu$  respectively. In the sample from Mt. Abu 64% of the individuals was having a width of 164  $\mu$ .

In addition to the variation in the size of the lorica the specimens showed marked variation in the presence of the posterolateral spines as well as in their length. There were no specimens with posterolateral spines in the sample from Jaipur. The specimens from Bikaner showed a mean length of 52  $\mu$  for the left posterolateral spine and 47.2  $\mu$  for the right spine. In the specimens from Pilani the posterior spines were comparatively smaller than that of the specimens of other samples. The maximum mean length for the posterolateral spines was shown by the specimens from Bikaner. In specimens of Khetri as well as Pilani the right posterolateral spine was much smaller than the left while in other samples they were of nearly equal size. There were only a few specimens with equally developed posterolateral spines in the samples.

Ahlstrom<sup>1</sup> suggests that 'forms lacking posterior spines are commonly larger in size than forms possessing posterolateral spines'. The present observation does not reveal such

correlation between the size of the lorica and the posterolateral spines. The specimens from Jaipur which are devoid of posterolateral spines are much smaller than the specimens from Khetri and Bikaner which have got posterolateral spines. Buchner *et al.*<sup>2</sup> suggests that poor feeding enhances the spine growth in *B. calyciflorus*. Nayar<sup>3</sup> suggested that the increase in the number of individuals as well as the production of additional structures depend upon the quantity of food available. It is assumable that variation in the size of the lorica and the posterolateral spines should be due to the difference in the nature and quantity of food available in the different localities.

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Department of Zoology, C. K. G. NAYAR.  
Birla College,  
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#### NERVE PATTERN OF THE PROTHORACIC SEGMENT OF THE LARVA OF *PRODENIA LITURA* (LEPIDOPTERA)

Our knowledge about the nervous system of lepidopterous larvæ is limited to a few forms only. The important contribution in the field has been made by Peterson,<sup>1</sup> Du Porte,<sup>2</sup> Swaine,<sup>3</sup> Hillemann<sup>4</sup> and Libby.<sup>5</sup> Presently, only the prothoracic segment has been taken into account in view of the abnormal nerve pattern.

The prothoracic ganglion gives rise to the anterior and posterior nerve roots on either side. The former, here called the *dorsal nerve*, leaves the ganglion from its antero-lateral margin and runs outwards and upwards over the ventral longitudinal muscles to meet the sub-connective nerve with which it forms a plexus. After forming the plexus, the dorsal nerve curves downwards, passes over the ventral longitudinal muscles and extends to a considerable distance, giving branches at intervals. The first branch (1D) arises over the 5th ventral longitudinal muscle and soon divides into two branches; the inner branch (a) innervates the 4th ventral longitudinal muscle and tracheæ while the outer one (b) innervates the 5th ventral longitudinal muscle and lateral muscle. The

second branch (2D) innervates the dorsal tergosternal muscles of the neck and the third branch (3D) supplies the dorsal longitudinal tergosternal muscles of the prothorax and the dorsal body wall of the neck and its muscles. After giving rise to the fourth branch (4D) which innervates the tergosternal muscles, the dorsal nerve terminates in the dorsal longitudinal muscles. Hillemann<sup>4</sup> has made no mention of the dorsal nerve in the larva of *Papilio polyxenes* but has shown a connective nerve to arise from the commissural cord between the oesophageal and prothoracic ganglia.

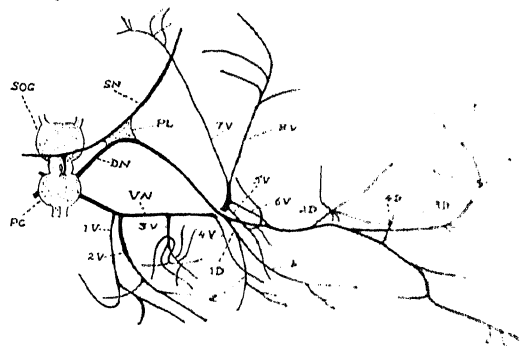


FIG. 1. Nerves of the right side of the prothoracic segment of the larva of *Prodenia litura*. DN, Dorsal nerve; 1D-4D, branches of the dorsal nerve; SOG, Sub-oesophageal ganglion; SN, Sub-connective nerve; VN, Ventral nerve; 1V-8V, branches of the ventral nerve; PG, Prothoracic ganglion; PL, Plexus.

The posterior nerve root, here called the *ventral nerve*, arises from the middle of the prothoracic ganglion at its lateral margin and extends to some distance giving out branches at intervals. The first branch (1V) runs obliquely downwards and ascends slightly outwards innervating the ventral external and internal oblique muscles and also the muscles of the proleg. The second branch (2V), arising immediately above the ventral oblique muscles, innervates the 1st inner ventral longitudinal muscles. The third nerve (3V) penetrates deep into the ventral musculature to supply tracheæ and muscles, whereas the fourth branch (4V) is a small one and innervates the tracheæ. The ventral nerve now flattens slightly and at the same time bends sharply to ascend anteriorly. This flattened portion of the nerve, which has not been reported earlier, gives rise to the fifth branch (5V) innervating the tracheæ and the 6th and 7th ventral longitudinal muscles and a sixth branch (6V) which joins the dorsal nerve above the 7th longitudinal muscle. Such a connection has been observed for the first time. Anteriorly, the ventral nerve bifurcates; the seventh branch

(7 V) innervates the ventral muscles of the head and its tracheae and the eighth one (8 V) supplies the ventral muscles of the neck.

There is no median nerve in this ganglion and as such the transverse nerves are also absent but these nerves are present in the other two thoracic ganglia. Du Porte,<sup>2</sup> however, figured the transverse nerves in the prothoracic region of *Sphida* larva without showing the median nerve. In *Sthenopsis* larva, Swaine<sup>3</sup> observed the median nerve, lying in front of the first thoracic ganglion, to be not always present and in the *Prodenia* larva also it has been observed only in three specimens. It is difficult to explain this individual variation. In the *Prodenia* larva, there is a pair of sub-connective nerves which is formed as a result of bifurcation from a single nerve arising from the mid-anterio-dorsal side of the prothoracic ganglion. These nerves have been reported to be present in *Protoparce carolina* larva (Peterson<sup>1</sup>) and absent in *Papilio* larva (Hillemann<sup>4</sup>).

The sub-connective nerve forms a plexus with the dorsal nerve and continues further into the head to supply the muscles. Peterson<sup>1</sup> reported a plexus formed between the sub-connective nerve, the prothoracic ganglion and the proximal ends of the lateral nerves. In the pterothorax of the larva of *Prodenia*, no plexus is present but the transverse and the dorsal nerves communicate by means of three connectives similar to *Sphida obliqua* (Du Porte<sup>2</sup>).

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## PHENOLIC ACIDS OF ONION PLANT, *ALLIUM CEPA*

The phenolic acids of green leaves of onion have not been investigated although Bate-Smith<sup>1</sup> has studied the phenolics in bulb portion. Since there could be considerable differences between the phenolic pattern of the storage region and rapidly metabolizing parts, the present investigation concerns the actively growing green

leaves and roots. The study of phenolics in different organs of the plant will also be helpful in understanding the mobilization of these substances within the plant.

The bulbs of onion, *Allium cepa* L., were planted in pans of sand in the garden. About 45 days after planting the entire plants were removed from sand, washed and were separated into the green foliage, the bulb and the roots. The different parts of the plants thus separated were analysed for the phenolic acids. The extraction of phenolic acids was carried out on weighed samples (approximately 10 g. batches) of leaves, bulb and roots, by grinding in 2 N hydrochloric acid and digesting in a boiling water-bath for about 20 minutes.<sup>2</sup> The digest was filtered and extracted with diethyl ether. The phenolic acids were taken up from ether extract into 5% sodium carbonate which was acidified and re-extracted with diethyl ether.

The final extract was concentrated and was subjected to paper chromatographic analysis using a two-directional ascending technique on Whatman No. 1 paper. The solvents used were benzene : acetic acid : water (60 : 70 : 30 upper phase) in the first direction and sodium formate ; formic acid : water (10 : 1 : 200)<sup>3</sup> in the second. The dried sheets were observed under ultra-violet light and were sprayed with diazotized *p*-nitroaniline<sup>4</sup> or diazotized sulphathiazole<sup>5</sup> in order to identify the various phenolic acids present. Authentic samples were also developed under identical conditions. The phenolic acids identified in different organs of the onion plants are shown in Table I.

TABLE I

Phenolic acids of different parts of onion plant

Plus (+) indicates presence: minus (-) indicates absence

Acid	Leaves	Bulb	Roots
Protocatechuic acid	.. +	+	-
Caffeic acid	.. +	+	+
<i>p</i> -Hydroxybenzoic acid	.. +	+	+
<i>p</i> -Coumaric acid	.. +	Trace	-
<i>o</i> -Coumaric acid	.. +	+	+
Ferulic acid	.. +	Trace	+
Sinapic acid	.. +	..	+

As seen from Table I it is clear that there are wide differences in the phenolic pattern of different parts of the plant. The acids found in the bulb region agree with the pattern reported by Bate-Smith.<sup>1</sup> The present investigation showed that *p*-hydroxybenzoic and *o*-coumaric acids are also present in the bulb in addition to caffeic, ferulic and sinapic acids. Caffeic,

o-coumaric and p-hydroxybenzoic acids are consistently present in appreciable quantities in all the organs. p-Coumaric, ferulic and sinapic acids are present in negligible quantities in the bulb while they are at maximum concentration in the leaves. Roots are characterized by the absence of p-coumaric and protocatechuic acids. Since p-coumaric acid is the precursor leading to the formation of other hydroxycinnamic acids, its absence in roots and the presence in large quantities of caffeic, ferulic and sinapic acids suggest that the latter are directly translocated from the green leaves rather than being synthesized in the root. However, further detailed investigation is necessary to determine the site of aromatic biosynthesis in the plant.

The authors thank Prof. I. M. Rao for encouragement.

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### CHROMOSOME "STRUCTURE" REVEALED BY SIMPLE TECHNIQUES

RECENTLY, papers have appeared in *Current Science* indicating that simple procedures such as fixation in N HCl at 60° C. followed by suitable staining can help in revealing the fine structure of chromosomes at mitotic pro- and meta-phases.<sup>1,2</sup> Subramanyam<sup>2</sup> hence feels that Taylor's<sup>3</sup> view that the structure of the chromosomes could rarely be made out at pro- and meta-phases with a light microscope needs revision. Over 25 years ago, photographs similar to those presented in the papers referred to above were published by Gates<sup>4</sup> and Mensinkai,<sup>5</sup> who also concluded that the pictures revealed a double coiled structure of chromatids. Darlington,<sup>6,7</sup> commenting on such pictures, pointed out that the fixative employed influences the products of fixation observed in the cell and that the appearance of two threads is an artefact induced by the fixative and due to bubbles of different refractive index in the chromatid. The bubbles may be of different sizes and the single line would sometimes be broken by 2 bubbles lying side by side as shown

in Figs. 1 to 5. Thus, one could infer 2, 3, 4 or more strands depending upon the size, placement and structure of the bubbles! The "diplochromosomes" of Subramanyam<sup>2</sup> are only vacuolated chromosomes in C-mitosis.



FIGS. 1-5. Root tip chromosomes of *Allium cepa* ( $2n=16$ ) fixed in N HCl at 60° C. for 15 minutes followed by Feulgen staining. Fig. 1. Metaphase. Fig. 2. Enlarged view of a chromosome from Fig. 1 showing bubbles of various sizes. Fig. 3. Anaphase. Figs. 4 and 5. Enlarged view of chromosomes from Fig. 3 showing bubbles of different sizes. Arrow shows 2 bubbles lying side by side giving a 3-stranded appearance to the chromatid.

In preparations involving acid fixative the chromatids of mitotic prophase sometimes appear double. Fixation in hot water may also reveal the doubleness but *in vivo* a doubleness has never been demonstrated. In the living state anaphase chromatids appear to be solid cylinders.<sup>8</sup> Studies of chromatid structure are difficult since the structural details are generally below the level of resolution of the light microscope and often above the size level at which the thin sections required for resolution in electron microscopy can give a complete picture. Hence, it appears desirable to base our conception of chromosome structure from data gathered from autoradiographic studies such as those described by Taylor.<sup>8</sup> Taylor's study strongly suggests that even the largest chromosomes consist of two sub-units of DNA and that the prophase chromosome may be essentially 2-stranded,

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### THE STRUCTURE OF THE CHROMOSOMES

There has so far been no unanimity of opinion on the structure of the chromosomes. A technique devised for the purpose to obtain reproducible pictures of chromosomes with Feulgen and haematoxylin stains, to reveal structures perfectly their internal structure. Recently Makinen<sup>1</sup> reported a series of failures similar results with our procedure. Unfortunately, the two bi-partite chromosomes, acrocentric, bi-coiled (Fig. 1c) being coiled, it was possible to show the coiled nature of a single chromosome (Fig. 2) was superimposed on that of a non-coiled anaphase chromosome.

It is surprising that comments published 23 years ago<sup>2</sup> are also repeated in Mazia, Nathan and Upadhyay.<sup>3</sup> The following quotations from a review of their papers<sup>4</sup> have already answered their criticism. The authors<sup>5</sup> have in a review of their earlier work, of the conception which was current in 1941, are stating that metaphase and telophase chromosomes developed already in anaphase, in a pasting, depending on conditions, according to the conditions. bubbles are formed of liquid drops in a liquid medium, in the presence of the incorrect view. The question of the possibility of a single thread in a chromosome is a misleading, because it is possible in one plane of two adjacent threads, which are around two other, as if they were a single, give, in plane, a superficial impression of alveoli side by side. But a photograph of this magnification cannot be taken in this dimension<sup>6</sup> (p. 60).

The second part of the Note of Mazia, Nathan and Upadhyay is a reproduction of some of the

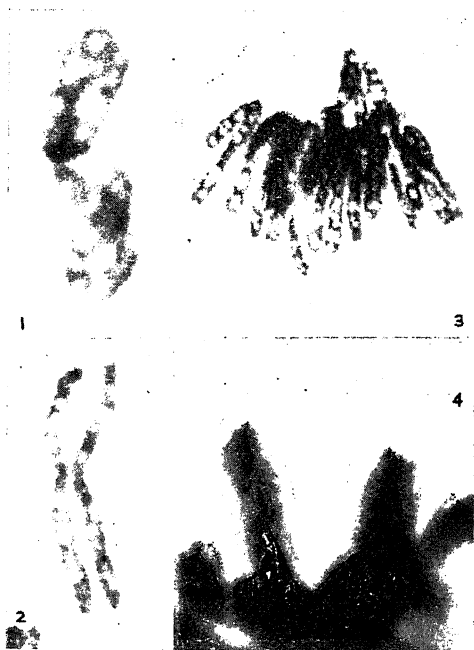
recent observations of Taylor<sup>7</sup> (pp. 67-68) on the above problem. As is to be expected, Taylor is not so dogmatic and in fact records exceptions where anaphase chromosomes have been shown to be double!! Best claims to have seen the split in ana- and telophase chromosomes of *Chlamydomonas* fibroblasts (p. 213). There appears to be no unanimity of opinion even among students of autoradiography. Pele and La Cour<sup>8</sup> argue that the chromosomes of *Vicia sativa* may be four stranded!

The heterochromaticity of the chromosomes from prophase till late anaphase has been interpreted to be the consequence of an RNA or RNA<sup>9</sup>. "The simplest picture of the RNA chromosome is that chromosomes pick up ribonucleoprotein at prophase and discard it in an equational direction at anaphase"<sup>10</sup> (p. 303). Zubay and Doty<sup>11</sup> consider that histone may, in some way, be coiled around the DNA double helix (see especially discussion in Bloch,<sup>12</sup> p. 226). La Cour<sup>13</sup> using autoradiography, has confirmed the presence of RNA in mitotic chromosomes and visualizes the possibility of the metaphase chromosome being the vehicle for the transport of nucleolar materials from prophase to telophase. The detailed analyses presented by Kaufmann, Gay and McDonald<sup>14</sup> (see their Tables) indicate that RNA and histones could be removed selectively by dilute acids.

Exposure of fresh root tips to N HCl<sup>15</sup> has thus a rationale. This was confirmed by the use of stain fixatives under controlled conditions.<sup>17</sup> The chromosome structure revealed was identical in both the above methods of approach. It is known that ribonucleoproteins are extracted by distilled water in material fixed in Carnoy's fluid<sup>18</sup>. The configuration of the chromosomes in a tissue fixed in acetic alcohol depends on the way it is handled. The chromosomes appear as solid exudates in fixed tissues stored in 70% alcohol for some days. If, on the other hand, the roots are processed soon after fixation, the meta- and ana-phase chromosomes appear generally as quadric and bi-partite (Fig. 3) respectively<sup>19</sup> (cf. Fig. 25 A, p. 172 of Mazia<sup>13</sup>).

The chromosome structure revealed by treatment with dilute acids is not superposable on that obtained by exposure to boiling water. Whatever may be the utility of boiling water in revealing the chromonematic coils in mitotic material, equally clear pictures of chromonemata in meta- and ana-phases of mitotic cells of *Allium cepa* root tips have not been presented so far.<sup>20</sup> In haematoxylin

squashes of root tips exposed to boiling water each chromosome has a distinct limiting membrane (Fig. 4). Attention is invited to the zone between the central chromatic core and the limiting pellicle of each chromosome (Fig. 4). This is the matrix referred to by



FIGS. 1-4. Fig. 1. A metaphase chromosome showing the relational coiling of the bi-partite chromatids (Fig. 8 of Subramaniam and Subramanyam<sup>1</sup>).  $\times$  ca. 3,850. Fig. 2. Each half of the diplo-chromosome is bi-partite (Fig. 4 of Subramanyam<sup>3</sup>).  $\times$  ca. 2,850. Fig. 3. An anaphase group from acetic alcohol-haematoxylin squash. Note the bi-partite configuration of each chromosome,  $\times$  ca. 1,550. (Courtesy: Royan-Subramaniam). Fig. 4. Portion of a metaphase plate showing a distinct membrane around each chromosome. Boiling water haematoxylin squash,  $\times$  ca. 3,350.

earlier investigators.<sup>21</sup> Boiling water produces a re-orientation of the chromonemata within the pellicle thus revealing the matrix (compare Figs. 1-3 with Fig. 4). It is this matrix, composed probably of RNA and histones, that is removed by the modified procedures<sup>1,17,19</sup> introduced by us to reveal the DNA containing chromonemata.

Cytogenetics Laboratory, M. K. SUBRAMANIAM.  
Department of Biochemistry, S. SUBRAMANYAM.  
Indian Institute of Science,  
Bangalore-12, June 9, 1964.

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## A NEW METER BASED ON DOPPLER EFFECT TO MEASURE UNDERWATER CURRENT FLOW

THE Gulton Industries, Metuchen, New Jersey, has announced a novel instrument to measure the speed and direction of underwater currents. It is a dual-channel, self-calibrating meter, designated Model MCV-1, and operates accurately (0.01 knot full scale) at depths as great as 1,000 feet for use both in oceans and inland waterways. This unique instrument uses Doppler effect to determine the current velocity and the direction of the current flow.

The system consists of a deck unit housed in a portable, watertight case and an underwater

transmitter and two receivers for hull mounting. The deck unit provides two simultaneous signals for each channel: an a-c output signal that varies in frequency with changes in velocity, and a d-c output signal that varies in amplitude with changes in velocity. The direction is ascertained by mounting the two receiving heads at right angles to each other. The d-c signal may be used to drive an x-y recorder. The deck instrument has two meters with four ranges each — 0.3, 1, 3 and 10 knots.—(*Jour. Frank. Inst.*, 1964, 277, 375.)



## REVIEWS

ings of the International School of Physics "Enrico Fermi", Varenna, Italy. Published by the Academic Press, Inc., 111, Avenue, New York-3, New York, U.S.A.) The International School of Physics was organized by the Italian Society of Physics at a Monastero in Varenna on the Lake of Como with a special purpose, viz., to provide courses which would enable research students to acquire the background of knowledge necessary for progress in their respective fields. The courses were designed mainly for experienced research students; nevertheless, they placed emphasis on theory at a level which was accessible to those attending the courses. Each course included besides lectures, also seminars in which the participants could present reports on their own investigations. The younger and less experienced investigators in the field were thus brought into contact with each other for their mutual benefit. The enterprise of the Academic Press has enabled the material presented in these courses to become available to students all over the world in a series of excellently printed and beautifully bound volumes.

**19 : Cosmic Rays, Solar Particles and Space Research.** Edited by G. Polvani, Pp. 418. Price \$16.00.

This course ran from May 23 to June 3, 1961, and its Director was B. Peters. The course was attended by sixty-two persons. The subject of the course was covered in four sections. The first section was on "The Relations between the Solar Wind and the Earth" and the following were the speakers: M. Hack—The surface of the sun; H. Elliot—An optical phenomenon associated with the solar IV solar radio emission; H. Elliot—Of cosmic-ray particles in the geomagnetic field; K. W. Ogilvie—Solar protons; J. A. Warwick—Propagation of solar particles in the interstellar magnetic field; E. R. Harrison—Solar corpuscular radiation and the nature of the earth's immediate interplanetary environment; A. A. Brunberg—The production of high-energy particles in the sun and in the solar wind.

The second section was on "The Problem of Cosmic-ray particles by magnetic pumping; A. A. Brunberg—The earth's radiation belts and cosmic rays; R. E. Gendrin—Mechanisms of cosmic-ray emission.

The third section was on "The Story of the Origin of Cosmic Rays" and the following were the speakers: J. Geiss, H. Oeschger and U. Schwarz—The history of cosmic radiation as revealed by isotopic changes in the meteorites and on the earth; J. Zähringer—Some recent investigations on primordial rare gases and  $^{129}\text{Xe}$  in meteorites; F. Hoyle—On the origin of cosmic rays.

The fourth and concluding section was on "The Instruments and the Programmes of Research" and the following were the speakers: G. H. Ludwig—The U.S. program for particles and fields measurements in space; G. H. Ludwig—Spacecraft information systems; E. B. Dorling—The British Space Research Programme; H. Elliot—Cosmic-ray measurements in the U.S./U.K. Satellite S-51; E.-A. Brunberg—Research and research plans at Kiruna geophysical observatory; M. Ceccarelli—Programs of radioastronomy in Italy; H. C. van de Hulst—International agreement as a vital factor in radioastronomy and space research.

**Course 21 : Liquid Helium.** Edited by G. Polvani, 1964. Pp. 442. Price \$16.00.

This course ran from July 3 to July 15, 1961, and its Director was G. Careri. The course was attended by sixty-three persons. The subject of the course was dealt with in two sections. The first section comprised lectures and the following were the speakers: J. De Boer—Excitation model for liquid Helium II; G. V. Chester—Superfluidity; C. C. Lin—Hydrodynamics of Helium II; D. Pines—Elementary excitations in a system of interacting bosons, with application to liquid Helium II; A. M. Sessler—Theory of Liquid  $^3\text{He}$ .

The second section comprised seminars and the following were the speakers: W. M. Fair-

bank—The nature of the  $l$ -transition in liquid Helium; J. F. Allen—Vorticity in the Helium film; S. Franchetti—On the theory of Helium film; H. E. Hall—Equations of motion for rotating Helium II; W. F. Vinen—Critical velocities in liquid Helium II; E. F. Hammel, W. E. Keller and P. P. Craig—Liquid Helium II heat conductivity and fountain pressure: measurements and calculations for narrow slits; K. Mendelssohn—The appearance of friction in superfluid Helium; K. W. Taconis and F. A. Staas—Laminar and turbulent flow of Helium II in wide capillaries; J. J. M. Beenakker and R. De Bruyn Ouboter—Dilute mixtures of  $^3\text{He}$  in superfluid  $^4\text{He}$ ; H. C. Kramers—Second sound and dissipative processes in very dilute  $^3\text{He}$ - $^4\text{He}$  mixtures; K. R. Atkins—The nature of ions in liquid Helium; C. G. Kuper—The structure and the mobility of ions in liquid Helium; G. Careri—Ions in liquid Helium. Some contemporary aspects; H. A. Fairbank—Properties of liquid  $^3\text{He}$  below  $1^\circ\text{K}$ ; D. F. Brewer—Properties of  $^3\text{He}$  near the melting curve.

**Course 22: Semi-Conductors.** Edited by G. Polvani. 1963. Pp. 540. Price \$ 22.00.

This course ran from July 17 to August 5, 1961, and its Director was R. A. Smith. The course was attended by seventy-two persons. The subject of the course was dealt with in a series of lectures given by the following speakers: R. A. Smith—Introductory lecture; L. Pincherle—Band structure of semiconductors; W. Cochran—Lattice dynamics; H. J. Vink—Interaction of imperfections in homogeneous and heterogeneous phase equilibria; A. F. Gibson—The transport of excess carriers in semiconductors; B. Lax—Cyclotron resonance and magneto-optical effects in semiconductors; N. B. Hannay—Semiconductor chemistry; N. B. Hannay—Transition-metal oxides; N. B. Hannay—Organic semiconductors; L. Sosnowski—Thermo-electric and thermo-magnetic effects; C. P. Enz—Magnetic susceptibility of semiconductors; T. P. McLean—The effective-mass approximation; F. A. Johnson—Lattice vibration spectra of semiconductors; S. H. Koenig—Piezoresistance in  $n$ -type germanium; S. H. Koenig—Piezoresistance in  $p$ -type germanium; R. A. Smith—Optical properties of semiconductors.

**Course 23: Nuclear Physics.** 1963. Pp. 186. Price \$ 7.50.

This course ran from August 7 to August 26, 1961, and its Director was V. F. Weisskopf. The course was attended by one hundred and

four persons. The subject of the course was dealt with in two sections. The first section comprised lectures and the following were the speakers: F. Villars—The Hartree-Fock approximation in nuclear physics; A. De Shalit—Nuclear moments; C. Levinson—Nuclear physics; G. E. Brown—Collective motion and the application of many-body techniques; T. Ericson—The compound nucleus and the random phase approximation.

The second section of the course comprised seminars and the following were the speakers: D. Bès and Z. Szymanski—Spurious state in connection with  $\beta$ -vibration of nuclei; H. H. Stroke—Distribution of nuclear charge and magnetization from atomic hyperfine structure; J. Unna—Effective interactions in deformed nuclei; J. E. Young—The interference of compound and direct processes.

C. V. R.

**Modern Polarographic Methods.** By H. Schmidt and M. v. Stackelberg, Institute for Physical Chemistry, University of Bonn, Bonn. (Academic Press, New York, London), 1963. Pp. v + 99. Price \$ 5.50.

During recent years many new modifications to the classical polarographic method have been incorporated making the polarographic technique more versatile. In the present book the authors have given a clear but brief account of the following techniques employed in polarography: differential polarography, derivative polarography, strobe polarography, oscillographic polarography, conventional alternating-current polarography, square wave polarography, a.c. bridge polarography, pulse polarography and radiofrequency polarography. Although greater experimental details would have been more welcome, yet the object of the authors in bringing out this volume seems to be only to deal with the problems of the methods rather than details of apparatus. The authors are specialists in theoretical polarography: yet the small size of the book could not allow them to introduce the mathematical derivations of even important equations. However, references have been given for such an information. The smallness of the size is also responsible for the authors' assumption of the basic knowledge of polarography on behalf of the reader including a good knowledge of electronics. In short the book serves as a useful guide to the advanced research worker interested in the application of modern polarographic techniques. The critical account on

A.C. polarographic methods in the first chapter is highly instructive and praiseworthy.

The publication of this book is to be welcomed by every polarographer and the reviewer has no hesitation in recommending this book to the workers in the field.

M. R. A.

**Biochemical Society Symposia—No. 22:** *The Structure and Function of the Membranes and Surfaces of Cells*. Edited by D. J. Benn and J. K. Grant. (Cambridge University Press), 1963. Pp. 172. Price 35 sh. net; **No. 23:** *Methods of Separation of Subcellular Structural Components*. Edited by J. K. Grant. (Cambridge University Press), 1963. Pp. 157. Price 35 sh. net.

The introductory remarks of F. G. Young in the first of these Symposia (No. 22) emphasize the importance of the study of cell membranes and also point out that the basic structure of cell membranes proposed by Danielli in 1934 still holds good.

The review on the isolation of microsomal membranes by Rothschild underlines the importance of gradient differential centrifugation in the separation of microsomal fractions and their sub-fractions. The heterogeneity of preparations obtained by this method has been pointed out and attempts to separate smooth-surfaced microsomal membranes have been described in detail.

The subject of surface structures of bacteria has been discussed by Rogers. The products of acid hydrolysis of cell-wall material were found to be amino-acids including the D-isomers. The differences in the mucopeptides obtained from gram-positive and gram-negative bacterial cell-walls have been described and models for the spatial arrangement of mucopeptides have been proposed.

The mechanism of Pinocytosis has been reviewed by Woodin. Though the mechanism of transport of ribonuclease, chymotrypsin and other enzymes across the membranes of pancreatic cells is not very clear, *in vivo* experiments suggest that the process is under hormonal control. The increased turnover of phospholipids during secretion has also been suggested to have a role in the transport of proteins.

Mitchell deals with the interesting concept of vectorial factors for the transport of molecules and groups through natural membranes. According to this author, the primary transport process of groups and electron translocation may be an important and versatile mechanism for coupling pairs of chemical processes automatically, although as the author himself points out, future work has to substantiate this view.

Concluding the Symposium, Danielli has ably summed up the problems that still confront us and remain to be answered in the study of cell membranes.

The succeeding number (No. 23) is mainly concerned with methods of separation of sub-cellular structural components, the scope and limitations of which have been assessed by De Duve. In the article that follows, Hughes and Cunningham have described the available methods for disrupting cells with particular emphasis on ultrasonic methods. The various procedures employed for disrupting cells have been diagrammatically represented and the electron micrographs clearly indicate the validity of the methods used.

The article by Roodyn contains a comprehensive account of the various methods that are in vogue for the isolation of nuclei from mouse and rat liver. Incidentally, the author points out the lack of uniformity in appearance, texture and physical state of the nuclei isolated by various workers employing different methods.

Conchie and Levy, while analysing the significance of subcellular fractionation in the study of certain hydrolytic enzymes, such as  $\beta$ -galactosidase and acid phosphatase are not very convinced of the existence of lysosomes as a separate class of cytoplasmic particles. But in the discussion that follows, De Duve refers to publications which support the view that lysosomes are characteristic cytoplasmic entities which are clearly defined both biochemically and morphologically. Whittaker has used subcellular fractionation in his studies on the distribution of acetyl choline in nerve tissues. He supports the lysosomal theory of De Duve and also points out the superiority of negative staining methods over those of thin sectioning.

The methods for the separation and isolation of homogeneous fractions of ribosomes and pure fragments of cytoplasmic membranes or oxidosomes of bacteria have been critically surveyed by De Ley. The advantages of density-gradient centrifugation on lactose or sucrose solutions over density-gradient electrophoresis are discussed.

The articles contained in these two volumes are tersely presented and the discussions that follow are thought-provoking and illuminating. Each article is followed by an impressive array of cross-references. There is, therefore, no doubt, that these two volumes would be a most welcome addition to any biochemical library.

N. K. SUKANYA.  
C. S. VAIDYANATHAN.

**International Conference on Cosmic Rays:** *Proceedings of VIII Conference in Jaipur, 1963. Extensive Air Showers* (Vol. 4). Pp. 322. Price Rs. 20-00; \$ 5.00. or £ 1-15-0. (For copies write to Secretary, I.C.C.R., Tata Institute of Fundamental Research, Bombay-5).

The Proceedings of the Eighth International Conference on Cosmic Rays held in Jaipur, India, from December 2-14, 1963, under the auspices of the Cosmic Ray Commission of the International Union of Pure and Applied Physics and the Department of Atomic Energy, Government of India, are being published in six volumes under the respective headings: Solar Particle Radiation and Sun-Earth Relations; Modulation; Composition; Extensive Air Showers; High Energy Interactions; and Muons and Neutrinos.

The volume under review is the fourth volume on Extensive Air Showers; and contains 35 contributions by more than 100 authors, and gives a complete record including the discussions.

The volume (size 8½" × 11" with paper covers) appears in photo-offset printing from typed manuscripts supplied by the authors. The reports being the results of latest investigations from many international centres of research will be welcomed by workers in the field all over the world.

**International Review of Cytology**, Vol. 15. Edited by G. H. Bourne and J. F. Danielli. (Academic Press, New York and London), 1963. Pp. ix + 444. Price \$ 16.00.

Lampbrush chromosomes have of late been attracting a lot of attention in the context of the significance of the lateral loops in relation to chromosome structure. The review by Callan on "The Nature of Lampbrush Chromosome" is therefore of topical interest. The live topic of the day, "Intracellular Transfer of Genetic Information" is surveyed by Sirlin. An attempt is made to analyse the problem posed by the question: "How does a sperm find an egg?" in the article, "Mechanisms of Gametic Approach in Plants" (Machlis and Rawitscher-Kunkel). Chemotactic and chemotropic reactions are said to be involved. "If, as is indicated, the chemotropic factor for the directed growth of pollen tubes is calcium, then it cannot even claim the name of hormone" (p. 135). The volume contains also equally interesting surveys on a variety of topics like "The Cellular Basis of Morphogenesis" (Gustafson and Wolpert), "Plant Tissue Culture in Relation to Cytology" (Partanen), "Regeneration of Mammalian Liver" (Bucher), "Role of Ascorbic Acid in

Collagen Formation" (Gould), "Behaviour of Mast Cells in Anaphylaxis" (Mota) and "Lipid Absorption" (Wotton). M. K. S.

### Books Received

- From: (Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y.):
- Advances in Biological and Medical Physics* (Vol. 9). Edited by J. H. Lawrence, J. W. Gofman, 1963. Pp. ix + 496. Price \$ 16.00.
- Photophysiology*—Vol. 1: *General Principles: Action of Light on Plants*; Vol. 2: *Action of Light on Animals and Micro-organisms, Photobiochemical, Mechanisms, Bioluminescence*. Edited by A. C. Giese, 1964. Pp. xiii + 441. xiii + 377. Price \$ 14.00; \$ 15.00.
- Pure and Applied Physics*—Vol. 17: *Theory of Superconductivity*. By J. M. Blatt, 1964. Pp. xii + 486. Price \$ 12.50; Vol. 16: *Energy Band Theory*. By Joseph Callaway, 1964. Pp. x + 357. Price \$ 10.00.
- Mathematics in Science and Engineering*—Vol. 12: *Dynamic Programming in Chemical Engineering and Process Control*. By S. M. Roberts, 1964. Pp. xiii + 457. Price \$ 14.50.
- Advances in Protein Chemistry* (Vol. 18). Edited by C. B. Anfinsen, Jr., M. L. Anson and J. T. Edsall, 1964. Pp. x + 335. Price \$ 14.00.
- Medicinal Chemistry*—Vol. 2: *Lipid Pharmacology*. By R. Paoletti, 1964. Pp. xiii + 533. Price \$ 17.50.
- Advances in Lipid Research* (Vol. 1). Edited by R. Paoletti and D. Kritchevsky, 1964. Pp. xii + 418. Price \$ 14.00.
- Methods in Carbohydrate Chemistry*—Vol. 4: *Starch*. Edited by R. L. Whistler, 1964. Pp. xvi + 335. Price \$ 13.50.
- Evolutionary and Genetic Biology of Primates*. Edited by John Buettner-Janusch, 1964. Pp. xi + 330. Price \$ 12.50.
- Standard Methods of Clinical Chemistry* (Vol. 4). By D. Seligson, 1964. Pp. xiv + 261. Price \$ 7.50.
- Advances in Heat Transfer* (Vol. 1). Edited by T. F. Irvine, Jr. and J. P. Hartnett, 1964. Pp. xi + 459. Price \$ 16.00.
- Primitive Motile Systems in Cell Biology*. Edited by R. D. Allen and N. Kamiya, 1964. Pp. xix + 642. Price \$ 22.00.
- Mineral Metabolism in Advanced Treatise* (Vol. 2)—Part A: *The Elements*. Edited by C. L. Comar and F. Bronner, 1964. Pp. xiv + 649. Price \$ 22.00.
- Physiological Mammalogy*—Vol. 1: *Mammalian Populations*. Edited by W. V. Mayer and R. G. Vangelder, 1964. Pp. xii + 381. Price \$ 12.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the Ph.D. Degree in Physics to Kum. K. Syamalamba for her thesis entitled "Theoretical and Experimental Studies on Dipole Moments and Relaxation Times of Certain Organic Compounds"; Ph.D. Degree in Nuclear Physics to Shri B. Somalinga Sastry for his thesis entitled "Studies on Disintegration Energies and Absorption of Beta Radiations"; D.Sc. Degree in Technology to Shri M. V. Ramana Rao for his thesis entitled "Diffusion-Controlled Electrode Reactions in Square Channels"; D.Sc. Degree in Zoology to Sri Y. Radhakrishna for his thesis entitled "The Systematics and Ecology of Bottom Fauna"; Ph.D. Degree in Botany to Shri V. Ramakrishna Reddy for his thesis entitled "Cytological Studies in the Genus *Sorghum*".

### Measurement of Raman Scattering Cross-Sections for Use in Calculating (SRS) Effects

Stimulated Raman Scattering (SRS), by which many Raman-active materials have been made to exhibit laser-like emission of coherent light is analogous to stimulated emission. When a Raman-active material is illuminated by a strong monochromatic source at angular frequency  $\omega$ , light waves at frequency  $(\omega - \Delta)$  may experience a gain (negative loss) when  $\Delta$  is at or near a Raman frequency. As the incident light becomes stronger, this gain can overcome losses so that growing waves at  $(\omega - \Delta)$  result.

For theoretical prediction of the SRS from a given Raman line, the differential Raman scattering cross-section at the peak of the line must be known, just as the peak absorption cross-section must be known for an ordinary laser line.

F. J. McClung and D. Weiner of the Hughes Research Laboratories, California, report Raman scattering cross-section measurements of three lines (of liquid benzene, nitrobenzene and toluene) for which SRS has been observed. The values of these measured cross-sections imply SRS characteristics in agreement with the experiments to date, and hence can be taken as direct evidence that SRS is the prime mechanism involved in the laser-like behaviour of these substances.

The peak differential cross-sections reported are: Nitrobenzene ( $1345 \text{ cm}^{-1}$ ),  $2.3 \text{ cm}^{-2}$ ;

Benzene ( $991.6 \text{ cm}^{-1}$ ),  $3.9 \text{ cm}^{-2}$ ; Toluene ( $1102 \text{ cm}^{-1}$ ),  $1.1 \text{ cm}^{-2}$ . Besides these three lines for which SRS has been measured and proved to be in agreement, measurements have been made for the following two lines also which can be used in calculating SRS effects: Benzene ( $1179 \text{ cm}^{-1}$ ),  $0.13 \text{ cm}^{-2}$ , and Toluene ( $1212 \text{ cm}^{-1}$ ),  $0.24 \text{ cm}^{-2}$ —(*Jour. Opt. Soc. Amer.*, 1964, 54, 641.)

### Giant Laser Pulse Using a Semiconductor Mirror

The reflectance at a semiconductor/air interface may be regarded as due partly to the dielectric properties of the material (arising from bound electrons), and partly to the metallic properties (arising from free electrons and holes associated with quantum states in the conduction and valence bands respectively).

In the case of germanium the dielectric properties usually predominate but intense light from a ruby laser, incident on the germanium surface, may generate sufficient electron-hole pairs locally to make the plasma contribution to reflectance appreciable. Initial calculations have shown this effect to be practicable.

The effect has been used to provide Q-switching in a ruby laser by replacing one of the usual metallic mirrors of the Fabry-Perot resonator with an optically flat germanium surface. Oscillograms showed that the light output of such a system consisted of many typical laser pulses of low intensity together with one or more 'giant pulses' the peak intensity of which was at least 40 times greater than that of any of the ordinary pulses. The width of the 'giant pulse' was about 60 ns.—(*Nature*, 1964, 202, 787.)

### Effect of Polarisation on the Albedo

The albedo (i.e., the proportion of incident sunlight reflected) has been determined for a great variety of terrestrial surfaces (snow, water, sand, etc.) by many observers. Although it has been noted that the albedo is dependent on solar elevation little thought seems to have been given to the mechanism underlying this dependence. P. Schwerdtfeger, of the Meteorological Department of the Melbourne University, suggests that a substantial part of it is a consequence of polarization which occurs when radiation is reflected and scattered by a

terrestrial surface, and that this effect is particularly significant for surfaces with structures which have undergone orientation by the wind.

He supports this suggestion by his observations made on Antarctic plateau wind-swept snow surfaces, using an ordinary twin-lens reflexion camera and a silicon photoelectric cell behind the camera lens. A conventional photographic polarizing filter was used in front of the lens as the analyser and rotated through  $360^\circ$ , the output of the solar cell being read at  $45^\circ$  intervals. His observations show that in the direction of the wind, the light from the surface is 20-22% polarized, while at right angles the polarisation falls to 7%. This polarisation was observed to be essentially independent of larger-scale surface features at any one locality, evidently being dependent rather on particle and crystal orientation of the surface snow. It may be surmised that the albedo of sand surfaces also should show similarities to that of snow.

It should be noted that where the incident light itself is partially polarized, as in the case of sky radiation, this factor also should be taken into account.—(*Nature*, 1964, 202, 894.)

### Three New NMR Spectrometers

Three new NMR research spectrometers featuring proton stabilisation control and a variety of system packaging and conversion options are now offered by the Analytical Instrument Division of Varian Associates for high resolution 60 or 100 MHz investigations.

The proton stabilization control feature of the new HA-60, DA-60, and HA-100 NMR Spectrometers eliminates the problem of field and frequency stabilities. Formerly, any occurrence which shifted the d-c magnetic field affected the NMR spectrum, resulting in line shifts, noise, line distortion and chart calibration inaccuracy. Now the Varian proton stabilization control system "locks" the d-c magnetic field to the response of a control sample, thereby providing previously unattainable stability in the production of spectra. The three new instruments also feature new integrated packaging arrangements.

The HA- and DA-systems are now supplied with a new flat bed recorder. Special pre-calibrated charts for proton spectra are used.

Calibration is in ppm and cps, with scales which match the recorder's five sweep ranges 50-1000 Hz, at eight speeds 25-5000 seconds selectable from the recorder control panel. Provision has been made for in-field conversion of existing Varian NMR spectrometers to accept the new stabilization components and the new recorder.

Blue Star Engineering Co. (Bombay) Private Ltd., Band Box House, Dr. Annic Besant Road, Worli, Bombay-18.

### Use of Eidophor in Teaching Medicine

In 1962 Laboratories CIBA, Paris, presented the new Faculty of Medicine in the University of Paris at the Sorbonne with an Eidophor television system. This was the first projector installed permanently in Europe for the purpose of facilitating teaching before a large body of students. Since its installation the system has been in steady use in anatomy, histology and embryology courses, and as an adjunct to lectures in physiology, enabling the transmission of laboratory demonstrations. According to *CIBA Journal* "the installation of a number of projectors in different halls is at present considered the best way of multiplying the possibilities of simultaneous instruction to thousands of students".—(*CIBA Journal*, Autumn 1963.)

### Rotational Speed of the Upper Atmosphere, at Heights of 200 to 300 km.

Because the atmosphere rotates, a close Earth satellite is subjected to small lateral aerodynamic forces which have the effect of slightly changing the inclination of the orbit to the equator. For an eastbound satellite the inclination decreases, sometimes by as much as  $0.1^\circ$ , and the amount of decrease is a measure of the angular velocity of the atmosphere at heights near that of the satellites perigee (nearest distance).

An analysis of available orbital data relating to changes in inclination of 9 satellites, covering the years 1958-63, heights of 200-300 km., and latitudes  $0-60^\circ$ , shows that the upper atmosphere to a height of 200-300 km. rotates faster (angular velocity 1.46 times) than the Earth with a mean west-to-east wind speed of order 100 m./sec. in mid-latitudes.—(*Nature*, 1964 202, 893.)

# MECHANISM OF INDUCTION OF OROTIC ACID FATTY LIVER

S. RAJALAKSHMI, D. S. R. SARMA AND P. S. SARMA

Department of Biochemistry, Indian Institute of Science, Bangalore-12

THE accumulation of abnormal quantities of lipid occurs generally as the result of an impairment of lipid metabolism. This condition is referred to as fatty liver. Experimentally fatty livers are produced by (a) deficiency of choline and related lipotropic factors, (b) hormonal imbalances, (c) Qualitative and Quantitative deficiency of protein and (d) by the administration of hepatotoxic agents. Nevertheless the work carried out in recent years indicates that an upset in the metabolic balance between purine and pyrimidine nucleotides may cause a derangement in lipid metabolism leading to the development of fatty liver. The present article is concerned with a review of the literature pertaining to the induction of such a fatty liver by the pyrimidine precursor orotic acid and a discussion of the mechanism by which orotic acid exerts its effect.

The development of fatty liver by orotic acid feeding was first observed in albino rats by Standerfer and Handler as early as 1955.<sup>1</sup> These workers noted infiltration of large quantities of triglycerides in the livers of weanling rats fed with a purified diet containing orotic acid at 1% level. The fatty liver induced by orotic acid was refractory to the action of the then known lipotropic substances. Another peculiar feature about orotic acid fatty liver was the occurrence of heavy fatty infiltration on a high casein, low fat and adequate choline diet. It is a well-recognised fact that such a diet is most unsuitable for the production of fatty liver. The report of Handschumacher *et al.*<sup>2</sup> on the reversal of orotic acid fatty liver by adenine aroused further interest in this type of fatty liver.

Recent work suggests the accumulation of fat as a consequence of orotic acid feeding is due to certain alterations in the metabolism of nucleotides, nucleic acid and protein. These changes precede the infiltration of fat that occurs as the result of orotic acid feeding and disappears before the removal of fat from the liver, after the administration of actinomycin-D, 6-azauracil and adenine. The biochemical changes that follow the administration of orotic acid for about five days to young rats are (1) accumulation of triglycerides and cholesterol, (2) disturbance in the metabolic balance between

purines and pyrimidines nucleotides, (3) alteration of nucleic acid metabolism, (4) changes in the utilisation of amino-acids for protein synthesis, (5) formation of liponucleoprotein (LNP).

## 1. CHANGES IN LIPID METABOLISM

(a) *neutral lipid*.—One basic metabolic disturbance induced by orotic acid administration was an accumulation of triglycerides in the liver. Changes in lipid metabolism due to orotic acid administration have been investigated in great detail.

The histological examination of the livers of orotic acid fed rats revealed a periportal distribution of fat; further the livers were cholesterolytic. The observations of Sidransky<sup>3</sup> indicate that if adult rats were to be used in the experiment instead of young weanling rats, fatty changes were more pronounced in the females than in the males. This difference in response to changes in lipid level was attributed to the effect of testosterone.

The fat which accumulated in the liver of orotic acid fed animal was newly synthesised and did not represent mobilisation from extra-hepatic tissues.<sup>4,5</sup> A major portion of the accumulated fat was in association with LNP described in the latter part of this review. The composition of the fat synthesised in the orotic acid treated rats was similar to that found in the untreated animals.<sup>4,5</sup> Fatty acid oxidation in the orotic acid fed animals remained relatively the same as found in the control rats. The total phospholipid content was unaffected by the administration of orotic acid. Hence, the accumulation of triglycerides appeared to be mainly due to enhanced lipogenesis and a defect in the transport of the lipid synthesised.

(b) *Changes in cholesterol metabolism*.—An increase in hepatic cholesterol level in orotic acid administered rat was first reported by us in 1961.<sup>6</sup> This observation has recently been confirmed by Windmueller.<sup>5,7</sup> The elevated level of cholesterol was not due to increased synthesis since the incorporation of both acetate-1-C<sup>14</sup> and mevalonic acid-2-C<sup>14</sup> was significantly reduced.<sup>8</sup> The depression of cholesterol synthesis was not due to homeostatic effect for the regulation of cholesterol level but due to a lack of Adenosine triphosphate (ATP).<sup>9</sup> The accumulation of cholesterol in the liver

occurred concomitantly with a reduction of this substance in the serum and carcass. This might suggest that the accumulation of hepatic cholesterol was a consequence of mobilisation of cholesterol from the extrahepatic tissues with impairment of its metabolism in the liver. The observations of Handschumacher *et al.* and Windmueller revealed a reduction of plasma triglycerides and phospholipid levels in the orotic acid treated rats.<sup>4,7</sup> The supplementation of orotic acid diet with adenine restored the level of lipid to normal in all the tissues. However, the specific activity of cholesterol after adenine administration was significantly higher than even the control rats. The purines and pyrimidines exert specific effect on cholesterol metabolism and are probably involved in the maintenance of the level of cholesterol in tissues.

The exact mechanism by which orotic acid stimulates lipogenesis is a matter for speculation and future research. In fact conditions which facilitate accumulation of lipid have been shown to depress lipogenesis as a result of homeostatic effect. However, no regulatory mechanism seems to be operating in the orotic acid fed animal for the control of fatty acid synthesis.

Three possibilities exist for the catabolism of the ring structure of orotic acid. The first involves the reversal of the *de novo* synthesis of pyrimidines. The second implicates the conversion of orotic acid to uridylic acid (UMP) with subsequent degradation to dihydrouracil, carbamyl  $\beta$ -alanine and to ammonia and carbon dioxide. The third pathway has been shown to exist in certain bacteria and proceeds via the intermediate formation of barbituric acid, to malonic acid and urea. The results of Von Euler *et al.*<sup>10</sup> indicate the preference of second pathway for the degradation of orotic acid in the rat. However, the administration of orotic acid in massive doses may induce in the rat the third pathway of degradation of uracil, whereby the intracellular concentration of malonic acid may get enhanced. Such an increase in the level of malonic acid in the cell can exert two effects. One is an impairment of tricarboxylic acid cycle by inhibiting succinic dehydrogenase; which in turn may lead to decreased formation of ATP in the mitochondria. The second is an activation of acetyl carboxylase—the enzyme that converts acetyl—COA to malonyl COA. Such an activation of acetylcarboxylase by citric acid, isocitric acid and malonic acid has been demonstrated in *in vitro* experiments.<sup>11</sup> However, whether malonic acid can exert a similar effect *in vivo* remains to be studied.

## 2. CHANGES IN NUCLEOTIDE METABOLISM

Almost the first and the earliest change noticeable following the administration of orotic acid was an expansion of uridine nucleotides (UMP) pool.<sup>10,12</sup> The increase in UMP manifested both in the nuclear and supernatant fractions of the liver.<sup>13</sup> The alteration of UMP was observable within 24 hours after the administration of orotic acid. The enhanced level was maintained as long as the animal was kept on orotic acid diet. Concomitant with the elevation of UMP, a profound fall in adenine nucleotides level including nicotinamide adenine dinucleotide (NAD) and its reduced form was observed. The decline of NAD and NADP was progressive and rapid following the ingestion of orotic acid by rat. This decrease was not due to an enhanced activity of NADase but to reduced synthesis attributable to a lack of adenine nucleotides.<sup>8</sup> The reason as to why the decrease of adenine nucleotides occurs as the result of administration of orotic acid is not known. The rate of incorporation of adenine-8-C<sup>14</sup> *in vivo* into acid-soluble nucleotides was not significantly reduced thereby suggesting the decline of adenine nucleotides level might not be due to a decrease in the synthetic capacity of the cell. The *in vitro* experiments of Von Euler *et al.*<sup>10</sup> revealed only a small inhibition of the formation of adeninenucleotides by orotate if phosphoribosyl pyrophosphate (PRPP) was kept in limiting amounts. In the same experiment however adenine competed more effectively for PRPP than orotate. Nevertheless, the pathway of conversion of adenine into nucleotides represents the salvage pathway and not *de novo* synthesis. The cell has to prefer this pathway under conditions where a rapid synthesis of nucleotides appears mandatory.

## 3. CHANGES IN NUCLEIC ACID METABOLISM

The work in the direction of following the changes in nucleic acid metabolism is very meagre. Recent experiments carried out in this laboratory concern mainly with the study of nucleic acid metabolism. In rats fed with orotic acid ribonucleic acid (RNA) per unit weight of defatted liver showed a decrease.<sup>6</sup> This decrease was found to be associated with the mitochondrial fraction. The nuclear microsomal and supernatant fractions did not exhibit any change with regard to the level of RNA. Our preliminary results<sup>6</sup> on the analysis of base composition of the liver RNA of rats fed with orotic acid indicated an increase in the pyrimidine content with a decrease in that of adenine.



Recent observations on the incorporation of labelled precursors such as orotic acid-6-C<sup>14</sup>, adenine-8-C<sup>14</sup>, P<sup>32</sup>-phosphate and formate-1-C<sup>14</sup> into nucleic acid provided further evidence for the synthesis of nucleic acid with altered base composition.<sup>13</sup> Subsequent work resulted in the detection of a nucleic acid in association with protein and lipid.<sup>13</sup> Such a change in the nucleic acid synthesis is bound to reflect on protein synthesis.

#### 4. CHANGES IN PROTEIN METABOLISM

It should be pointed out at the outset that the level of total protein in the various subcellular fractions such as nuclear, mitochondrial, microsomal and supernatant remained relatively unchanged in the orotic acid treated rat except for the protein which was found in association with LNP. The latter was not found in the normal rats. However, the rate of utilisation of various amino-acids for protein synthesis was different in the orotic acid administered rats when compared with that of control rats. Thus the incorporation of phenylalanine-U-C<sup>14</sup>, and tryptophan-7-C<sup>14</sup> into the proteins of various subcellular fractions was significantly enhanced, whereas that of valine-1-C<sup>14</sup> was markedly reduced. The incorporation of Lysine-U-C<sup>14</sup> showed no change except for a decrease in mitochondria<sup>13</sup> and an increase in the supernatant fraction. Rubin *et al.*<sup>14</sup> have reported that the incorporation of leucine-C<sup>14</sup> was unaltered into the total proteins of the liver. It is interesting to note the coincidence of an enhanced uridine nucleotide level in RNA and an increased *in vivo* incorporation of phenyl alanine into liver proteins. It may be concluded that the type of protein synthesised in the orotic acid fed animals is different from that of the control rats. The alteration in the rate of uptake of amino-acids has been demonstrated only in bacteria grown in the presence of purine and pyrimidine analogues such as 8-azaguanine and 5-fluorouracil. No reference is available in the literature to indicate that such an effect can be brought about by a simple metabolite like orotic acid. It is pertinent to mention in this connection the results obtained by Hankin<sup>15</sup> on the levels of lipoproteins in orotic acid administered rats. Hankin<sup>15</sup> noted a decrease in the level of hepatic lipoproteins. Although the level of lipoproteins is diminished in the treated rat, the proportion of fat in these lipoproteins was more than twice as found in the untreated rats. Inhibition of lipoprotein synthesis has been suggested by Windmueller<sup>5</sup> on the basis of a reduction in the level of plasma lipoproteins. Rubin *et al.*<sup>14</sup> have

observed a decreased incorporation of leucine-1-C<sup>14</sup> into plasma lipoproteins. In view of our results on incorporation of amino-acids into liver proteins of orotic acid fed rats, it is necessary to be cautious before arriving at any conclusion on protein synthesis on the basis of incorporation of a single amino-acid. It will also be very difficult to determine whether the accumulation of fat is due to an inhibition of lipoprotein synthesis or to the synthesis of wrong protein. More detailed investigation is called for particularly since this problem is further complicated by detection of LNP in the liver of the orotic acid fed rat.

#### 4. FORMATION OF ACTINOMYCIN-D SENSITIVE LNP

During the isolation of various subcellular fractions by differential centrifugation a "white fluffy material was noted always in the topmost layer of the homogenizing material. By careful processing and analysis of this substance it was found to be a "liponucleoprotein". Details regarding the isolation and few characteristics of this LNP have recently been reported.<sup>13</sup> In Table I are given the results on the incorporation of radioactive amino-acids, orotic acid,

TABLE I  
The incorporation of nucleic acid precursors and amino-acids into Lipo-nucleo-protein (LNP) of orotic acid treated rats

Precursors injected	cpm./gm. of the Lipo-nucleo-protein (LNP)
*Orotic acid-6-C <sup>14</sup>	10,000
*Adenine 8-C <sup>14</sup>	24,000
*Formate-1-C <sup>14</sup>	11,550
*Phenyl alanine-U-C <sup>14</sup>	20,000
*Lysine-U-C <sup>14</sup>	6,400
*Valine-1-C <sup>14</sup>	8,000
*Tryptophane-7-C <sup>14</sup>	25,000

\* 2  $\mu$ c of each were injected intraperitoneally and the rats were sacrificed 8 hours after administration.

adenine and formate into LNP. The rate of incorporation of orotic acid-6-C<sup>14</sup> was significantly higher into this fraction than nuclear, microsomal, mitochondrial and supernatant fractions of the liver. Alkali hydrolysis and separation of liberated 2', 3'-nucleotides revealed the presence of adenylic, guanylic, uridylic and cytidylic acids. When orotic acid-6-C<sup>14</sup> was used as the marker in the synthesis of LNP, it was completely released by RNase action. Chromatography of the reaction mixtures after RNase digestion resulted in the release of UMP and CMP. Pulse-labelling experiments using orotic acid-6-C<sup>14</sup> indicated that the nucleic acid

moiety of LNP was rapidly synthesized. Actinomycin-D abolished almost completely the incorporation of orotic acid-6-C<sup>14</sup> into the nucleic acid part of LNP.

The entire complement of RNA of both mammalian and bacterial systems is produced in the actinomycin-D sensitive and DNA dependent reaction. The synthesis of nucleic acid moiety of LNP also seems to require continuous nuclear function. The detection of LNP in the orotic acid fed rat prompted us to investigate the effect of actinomycin D on the orotic acid fatty liver. The results of this investigation are summarized in Table II. It is interesting to

TABLE II

Effect of actinomycin-D on the incorporation of orotic acid-6-C<sup>14</sup> into the RNA of cellular fractions and Lipo-nucleo-protein (LNP) of orotic acid fed rats

Fractions	cpm./gm. nucleoprotein	
	Control	Actinomycin-D treated
Whole homogenate	.. 6,150	1,000
Nuclear	.. 5,650	1,000
LNP	.. 10,000	2,000

Actinomycin-D was injected at a concentration of 2 mg./kg. body weight intraperitoneally.

note the disappearance of LNP within 48 hours after administration of actinomycin-D. The lipid level decreased progressively thereafter and completely disappeared in 72 hours, following the administration of actinomycin-D. The reversal of orotic acid fatty liver by 6-azauracil was reported by Habermann *et al.*<sup>16</sup> The administration of 6-azauracil to orotic acid fed rats for about three days resulted in the disappearance of LNP. No accumulation of fat also could be observed in rats given 6-azauracil. The prevention of fat accumulation by adenine supplementation has been noticed by all workers. The effect of adenine on LNP formation is under study and preliminary data show that it might follow the same pattern as that of actinomycin-D.

6-Azauracil has been shown to prevent the formation of UMP from OMP by inhibiting the activity of OMP decarboxylase. The reversal of the effects of orotic acid by this compound suggests that the formation of UMP from the ingested orotic acid is an essential step in inducing various metabolic changes. The reversal of orotic acid fatty liver by actinomycin-D indicates that not only the formation of UMP but also that the utilisation of the UMP towards

nucleic acid synthesis is responsible for the initiation of the effects of orotic acid. Hence the principal ways by which the effects of orotic acid can be nullified are:

1. Prevention of formation of UMP from orotic acid by 6-azauracil.
2. Inhibition of utilisation of formed UMP towards nucleic acid synthesis by actinomycin-D.
3. Increase of adenine nucleotides via the salvage pathway by providing the exogenous adenine.

All the results discussed above are observed in the albino rats. It is interesting to note that in albino mouse and chick, the administration of orotic acid did not produce fatty liver.<sup>17</sup>

In conclusion it may be stated that fatty livers in albino rats can be caused by various means. The fatty liver induced by orotic acid was refractory to the action of the classical lipotropic substances. Another peculiar feature about orotic acid fatty liver was the occurrence of heavy fatty infiltration on a high casein, low fat and adequate choline diet. However; orotic acid fatty livers can be reversed by adenine, 6-azauracil and actinomycin-D. The details of the mechanism by which orotic acid produces the fatty liver and the probable mechanism of reversal by adenine, 6-azauracil and actinomycin-D have been described.

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OBSERVATIONS ON THE RÔLE OF BLUE-GREEN ALGAE ON RICE YIELD  
COMPARED WITH THAT OF CONVENTIONAL FERTILIZERS\*R. SUBRAHMANYAN, L. L. RELWANI AND G. B. MANNA  
Central Rice Research Institute, Cuttack

**B**OTH field and pot experiments in progress since 1961 at the Central Rice Research Institute with emphasis on the former, to study the rôle of blue-green algae in the nitrogen enrichment of the soil as well as conditioning of the soil for their proper manifestation such as addition of chemical nutrients, e.g., lime, superphosphate and sodium molybdate (trace) together (no nitrogenous fertilizers employed), definitely indicated the beneficial rôle of blue-green algae in increasing grain yield to the extent of 82% over no manure control. Some of the results have already been published (Relwani, 1963; Relwani and Subrahmanyam, 1963).

of blue-green algae—*Nostoc sphaericum*, *N. amplissimum*, *Tolypothrix campylonemoides* and *Westiella* sp.—grown in the laboratory by one of us (R. S.) and tested for their nitrogen-fixing capacity, were used for field inoculation. It may be mentioned in this connexion that a mixture of known nitrogen fixers is more efficient than inoculation of a single species (Subrahmanyam and Sahay, 1964, in press).

The results are presented in Table I. The data show that inoculation of blue-green algae alone increased the grain yield significantly by about 30% over the corresponding control (no manure) treatment and this is found to be statistically on the same level as 20 kg. N/ha.

TABLE I

Yield and post-harvest biometrical data (average of four replications) pertaining to the main crop season of 1963—variety T. 141 (field experiment)

Treatment (over basal dressing of lime, superphosphate and sodium molybdate)		Grain yield (Kg./Ha.)		Straw yield (Kg./Ha.)		Height (cm.)		Effective tillers per hill	
		A	B	A	B	A	B	A	B
Check (No manure)	..	2615 (100)	3403 (130)	2496 (100)	3657 (147)	131.4 (100)	137.9 (105)	3.60 (100)	5.51 (153)
Farm-yard manure @ 20 Kg. N/ha.	..	3392 (130)	3537 (137)	5483 (140)	3657 (147)	137.6 (105)	139.2 (106)	4.64 (129)	5.12 (142)
Green manure ( <i>Sesbania speciosa</i> ) @ 20 Kg. N/ha.	..	3907 (149)	3902 (149)	4238 (170)	4412 (177)	140.7 (107)	145.9 (110)	5.42 (151)	5.80 (161)
Ammonium sulphate @ 20 Kg. N/ha.	..	3431 (131)	3472 (132)	3588 (144)	3861 (155)	139.2 (106)	140.9 (107)	4.81 (134)	4.98 (138)
Urea @ 20 Kg. N/ha.	..	3366 (129)	3585 (137)	3454 (138)	3715 (149)	136.0 (104)	141.2 (108)	4.74 (132)	4.93 (137)

C.D. (0.05) per hectare .. 215

C.D. (0.10) per hectare .. 291

(Figures in brackets represent per cent. increases over check.) A—Without blue-green algae. B—With blue-green algae.)

Based on the above findings, a replicated conventional organic manures and fertilizers such as farm-yard manure, green manure, urea field experiment was conducted during the main crop season of 1963 (July-December) with a popular high-yielding variety of paddy, T 141 (145 days' duration), to test the efficiency of blue-green algae alone and in combination with and ammonium sulphate to supply 20 kg. N/ha. over a no manure control, all treatments being superimposed over a basal dressing of lime at 500 kg., superphosphate at 20 kg.  $P_2O_5$ /ha. and sodium molybdate at 0.28 kg./ha. Four species

applied in the forms of farm-yard manure, urea and ammonium sulphate. None of the manures or fertilizers was found to enhance significantly the efficiency of blue-green algae except urea. It may be observed that the response of blue-green algae is not as high as that obtained with green manure possibly because this is the first year of the inoculation of the algae. Experimental evidence indicates that the population of blue-green algae can be strengthened by successive inoculation during a few more crop seasons by which time these algae can get well acclimatised to the environment and cause progressive increases in crop yield (unpublished data). The observations of De and Sulaiman (1950) based on pot culture experiments lend support to this view mentioned above; they found that

\* The substance of this paper was presented at the IX Meeting of the International Rice Commission (F.A.O.) Working Party on Rice Soils, Water and Fertilizer Practices, held at Manila, in March, 1964.

the fourth and fifth year in a five-year course of experiments in the presence of algæ gave a much higher yield than those in which no algæ were present as well as than those at the start of the experiments.

The expression of algæ in conjunction with organic manures and ammonium sulphate is not evident, presumably due to the fact that as nitrogen in the form of ammonia is readily available for its growth most forms do not fix atmospheric nitrogen. It may be noted here that ammonia is the key intermediate in nitrogen fixation by blue-green algæ (Fogg, 1963). Differential behaviour with urea resulting in significant response needs confirmation before a satisfactory explanation can be offered.

Further, the significantly higher yield of crop with green manure over other popular manures may be attributed to the fact that though, on equal nitrogen basis, green manure produces similar yield as ammoniacal fertilizers (Nair, 1953); its efficiency is always more with superphosphate (Vivekanandan and Raja, 1964) and still more with addition of lime which helps the mineralization process of the green manure (Jochim in Mukherjee and Agarwal, 1950).

The trend observed in respect of biometrical data recorded from various treatments conforms to the trend of the grain and straw yield of the respective treatments (Table I).

We thank Dr. R. H. Richharia, Director, Central Rice Research Institute, for suggesting this problem and for his interest and encouragement during the investigation and Mr. S. Y. Padmanabhan, Mycologist, for presenting the paper on our behalf at the I.R.C. Meeting held at Manila in March, 1964.

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## RAMAN MASER ACTION WITH ACOUSTIC WAVES — STIMULATED BRILLOUIN SCATTERING

**S**TIMULATED Brillouin scattering of an intense maser beam, involving coherent amplification of a hypersonic lattice vibration and a scattered light wave, has been detected in quartz and sapphire. This has been reported in a communication to *Phys. Rev. Letters* (25 May, 1964) by R. Y. Chiao, C. H. Townes and B. P. Stoicheff. This process is analogous to Raman maser action, but with molecular vibration replaced by an acoustic wave of frequency about  $3 \times 10^{10}$  cps, and with both the acoustic and scattered light waves emitted in specific directions.

In this phenomenon either compressional or shear waves can be excited, but for a compressional wave the coupling between acoustic and optical waves is simplest, and describable as electrostriction. Electrostrictive pressure is given by  $p = (E^2/8\pi) \, d\epsilon/d\rho = (E^2B/8\pi) \, d\epsilon/d\rho$ , where  $E$  is the electric field,  $\rho$  the density of material,  $\epsilon$  the dielectric constant and  $B$  the bulk modulus. Thus two optical waves whose frequencies differ by  $\omega_s$  can drive a pressure wave of this frequency, due to quadratic dependence of pressure on  $E$  and the consequent generation of a beat frequency. Similarly a pressure wave of frequency  $\omega_s$  couples to an electromagnetic wave  $E$  through the varying induced dipole moment density  $(E/4\pi) \, (d\epsilon/d\rho) \rho$ .

The authors discuss the conditions for the build-up of the acoustic and scattered waves when the radiation is contained in a resonant cavity, and show that under these conditions coherent scattering of radiation of frequency  $(\omega_o - \omega_s)$  occurs in the direction  $\theta$  given by  $\omega_s = 2\omega_o (vn/c) \sin \frac{1}{2}\theta$ , where  $v$  is the velocity of the acoustic wave of frequency  $\omega_s$ ,  $n$  the refractive index and  $\theta$  is the angle between the incident and scattered radiation.

In the experimental set-up intense 6940 Å radiation from a giant-pulse ruby laser, with a power output of about 50 megawatts during 30 nsec., was focussed inside the quartz crystal and the backward (180°) scattered radiation was studied with the aid of two Fabry-Perot interferometers using mirrors of reflectance 1 and 0.1. A comparison of the two interferograms photographed simultaneously with a single maser pulse distinguished clearly between radiation coming from the ruby, and that scattered directly backward from the sample. In the light back-scattered from the sample the original ring due to the maser wavelength was accompanied by an inner ring of comparable intensity which was evidently the amplified Brillouin scattering. Measurement of the shift corresponded to an acoustic wave frequency near  $3 \times 10^{10}$  cps.—(*Phys. Rev. Letters*, 25 May 1964, p. 592.)

## LETTERS TO THE EDITOR

### MAGNETIC STUDIES ON RARE EARTH ETHYL SULPHATES

THE determination of the symmetry and strength of the crystal field acting on the rare earth ions in crystals has focused the attention of a number of workers.<sup>1,2</sup> Among the main experimental methods available for this determination, paramagnetic resonance method only has been extensively used. This method gives  $g$ -value (spectroscopic splitting factor), which depends on the splitting of the lowest state by the magnetic field and several sets of crystal field parameters may exist which make a particular state as the lowest to get the observed  $g$ -values. Consequently PMR studies only are inadequate for the determination of exact Crystal field parameters.<sup>9</sup> The principal magnetic susceptibilities depend not only on the form of the lowest state but also on some higher states and hence their studies will provide very valuable informations about the exact symmetry and strength of the crystal field.<sup>10</sup> Therefore a general programme to study the principal magnetic susceptibilities of rare earth ions in the crystals of sulphates, halides, double nitrates and ethyl sulphates from room to liquid air temperatures, has been undertaken in this laboratory. The present communication reports about some rare earth ethyl sulphates which are hexagonal.

Using the method of Krishnan and Banerji<sup>3</sup> the magnetic anisotropy was measured; the absolute susceptibility in a convenient direction was measured by a microbalance<sup>4</sup> and the temperature variation of the magnetic anisotropy by a cryostatic device<sup>5</sup> using a null method.<sup>6</sup> The results of measurements are shown in Table I. For comparison earlier available values are also included.

$X_{||}$  represents the gram molecular susceptibility along the hexagonal axis of the crystal and  $X_{\perp}$  that for directions normal to it.  $\Delta X_{300}$  denotes  $(X_{||} - X_{\perp})$  at 300° K. and  $\Delta X_{85}$  that at 85° K.  $(X_{||} + 2X_{\perp})/3 = X$ , represents the mean magnetic susceptibility.

The result of erbium ethyl sulphate as is shown in Table I, besides being nearly two and a half times that of Fereday and Wiersma<sup>7</sup> has opposite sign, but agrees with that of Krishnan and Mookherji.<sup>8</sup>

TABLE I  
Magnetic anisotropy

Ion	$\Delta X_{300} \cdot 10^6$			$\frac{\Delta X_{300}}{X}$	$\frac{\Delta X_{85}}{\Delta X_{300}}$
	Present work	Krishnan and Mookherji <sup>8</sup>	Fereday and Wiersma <sup>7</sup>		
Nd <sup>3+</sup>	298.8	303	300	+0.6	13.5
Sm <sup>3+</sup>	48.5	50	..	+0.9	.65
Ho <sup>3+</sup>	4953	..	..	-11	13.7
Tb <sup>3+</sup>	9877	..	..	-24	14.3
Er <sup>3+</sup>	-3101	-3245	+1295	-0.9	13.6

The increase of  $\Delta X$  from room temperature to liquid air temperature is about 14 times for all the ions studied except for Sm<sup>3+</sup> where there is a decrease.

Details will be published elsewhere.

Physics Laboratory,  
The University of Burdwan,  
India, July 11, 1964.

T. MOOKHERJI.

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### FURTHER INVESTIGATIONS ON 'Z' DEPENDENCE OF RAYLEIGH SCATTERING OF GAMMA RAYS

IN our earlier investigations<sup>1-3</sup> on the behaviour of the variation of the index to the power of 'Z' with the momentum transfer involved in Rayleigh scattering of gamma rays, we studied the scattering of 662 keV and 280 keV gamma rays from different elements through suitable angles so that the coherent scattering could be

TABLE I  
Z-dependence of 411 keV gamma rays

Scattering angle (°)	Momentum transfer	Differential scattering cross-section in $10^{-27}$ cm. <sup>2</sup> per ster.				Index ( <i>n</i> ) to the power of Z
		Pb	W	Sn	Ag	
60	0.80	48 ± 5	30 ± 4	15 ± 3	..	2.9 ± 0.6
75	0.98	30 ± 3	24 ± 4	6.0 ± 1	..	3.7 ± 0.4
90	1.14	20 ± 1	15 ± 1	2.8 ± 0.2	2.4 ± 0.2	4.0 ± 0.2
105	1.28	17.0 ± 1	12 ± 2	1.7 ± 0.2	1.1 ± 0.3	4.6 ± 0.2
120	1.39	17.0 ± 1	10.4 ± 0.4	1.5 ± 0.1	1.1 ± 0.1	4.6 ± 0.2
135	1.48	15.7 ± 0.7	8.8 ± 0.4	1.2 ± 0.1	1.0 ± 0.1	4.7 ± 0.2
150	1.55	14.7 ± 0.8	8.8 ± 0.5	1.2 ± 0.1	1.0 ± 0.1	4.8 ± 0.2

easily isolated from incoherent scattering. In order to get more information about this variation it was considered desirable to extend similar measurements to 411 keV gamma rays. The scattering of 411 keV gamma rays through  $60 \leq \theta \leq 150$  involves momentum transfer from 0.80 to 1.55, a region which could not be covered either by 280 keV or by 662 keV gamma rays alone but was investigated in two parts: (i) from 0.80 to 1.0 by the scattering of 280 keV gamma rays, and (ii) from 1.20 to 1.6 by the scattering of 662 keV gamma rays. The method of measurement was the same as used earlier. Gamma rays of energy 411 keV were obtained from Au-198. Since its half life is only 2.7 days, sequence of taking observations was so arranged as to minimize the effect of source decay. The results are given in Table I which gives scattering angle, momentum transfer, the scattering cross-sections from various elements and the values of the index to the power of 'Z'. The present experimental data when combined with the results of previous investigations show that the value of the index to the power of 'Z' decreases continuously with momentum transfer involved in scattering, irrespective of the energy of gamma rays.

Physics Department,  
Punjab University,  
Patiala, July 13, 1964.

M. SINGH.  
S. ANAND.  
B. S. SOOD.

### MAGNETIC MOMENTS OF CLATHRATE COMPOUNDS

The magnetic moments in Bohr magnetons per one nickel atom of nickel cyanide-ammonia<sup>1,2</sup> and its clathrates<sup>3</sup> were calculated at room temperature. As can be seen from Table I

TABLE I

Compound		Bohr magnetons
Ni(CN) <sub>2</sub> ·NH <sub>3</sub>	Nickel cyanide-ammonia	2.21
Ni(CN) <sub>2</sub> ·NH <sub>3</sub> ·C <sub>6</sub> H <sub>6</sub>	Benzene clathrate	2.25
Ni(CN) <sub>2</sub> ·C <sub>5</sub> H <sub>5</sub> N	Pyridine clathrate	2.20
Ni(CN) <sub>2</sub> ·NH <sub>3</sub> ·C <sub>4</sub> H <sub>5</sub> N	Pyrrole clathrate	2.24
Ni(CN) <sub>2</sub> ·NH <sub>3</sub> ·C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	Aniline clathrate	2.26
3 Ni C <sub>2</sub> N <sub>2</sub> ·3 NH <sub>3</sub> ·C <sub>4</sub> H <sub>4</sub> S	Thiophene clathrate	2.22
Mean:		2.23

the effective magnetic moments of these compounds are very close to one another and are definitely smaller than the spin-only value of 2.83 Bohr magneton for divalent nickel. This similar or nearly identical value of the magnetic moment of the nickel atom in all its compounds suggests that the two components of a clathrate do not react chemically with each other. Or the enclosure of the organic molecules within the nickel cyanide-ammonia cage to form clathrates cannot be expressed by the usual valence bond structures. This is in accordance with Powell<sup>4</sup> who has shown that the guest molecules in a clathrate compound are not linked by chemical bonds but are simply trapped in the crystal lattice.

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The results clearly show that the organic molecule which enters the structure of the clathrate compound hardly affects the magnetic properties of the clathrate compound in which it is entrapped. Kondo and Kubo<sup>5</sup> suggested the presence of equal numbers of nickel atoms having no unpaired electrons and those having two odd electrons. The mean magnetic moment resulting from spin contribution was given by,

$$\left[ \frac{1}{2} \{ 0(0+2) + 2(2+1) \} \right] \\ = 2.00 \text{ Bohr magneton}$$

the excess of the observed moment over this value, 2.23 Bohr magneton,<sup>5</sup> attributed to the orbital contribution. Their value corresponds with the mean value of magnetic moments, 2.23 Bohr magneton, of our clathrates. The following magnetic data found in literature on benzene clathrate are in good agreement with the present work: 2.24,<sup>5</sup> 2.23,<sup>6</sup> 2.27,<sup>7</sup> 2.32,<sup>8</sup> and 2.1.<sup>9</sup>

I am indebted to Dr. A. R. H. Cole (University of Western Australia), Prof. V. Caglioti (University of Rome) and Italian National Research Council.

Istituto di Chimica,  
Generale ed Inorganica,  
Roma, Italia,  
University di Roma, June 5, 1964.

V. M. BHATNAGAR.\*

\*Post-Doctoral Fellow, 1963-64. Address after August, 1964: Czechoslovakia Academy of Sciences, Brno Czechoslovakia.

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### MICROFILARIA IN DOMESTIC RATS (*RATTUS RATTUS RATTUS*) IN KERALA STATE, INDIA

DURING the routine survey for animal filariasis in Calicut Corporation of Kerala State, 95 domestic rats (*R. rattus rattus*) were examined for the filarial infection. Microfilariae were detected in 3 of them. One specimen each of *Bandicoota malabaricana* and *Mus musculus* examined similarly was found to be negative.

The microfilariae are unsheathed and non-periodic. The measurements of the anatomical points of microfilariae are given below (Fig. 1):

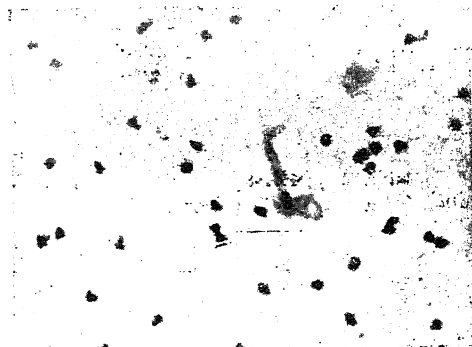


FIG. 1

#### Measurement of Rat microfilaria

Average length of microfilaria ..	133.41 μ
Average breadth of microfilaria ..	4.8 μ
Average length of cephalic space ..	3.04 μ
Average breadth of cephalic space ..	3.04 μ
Average length from anterior end to excretory ring ..	46.03 μ
Average length from anterior end to nerve ring ..	29.12 μ
Average length from anterior end to anal pore ..	109.12 μ

The cephalic space is free from nuclei, but the nuclei extend up to the tip of the tail end which is blunt.

The results of the periodicity studies are given in Table I.

TABLE I

Showing the results of periodicity study conducted on rat having filaria infection

Time	10 A.M.	2 P.M.	6 P.M.	10 P.M.	2 A.M.	6 A.M.
Number of microfilaria per 20 cmm. (Average of two smears)	23.5	36.0	17.5	9.0	25.0	19.0

From the morphological appearance of the microfilaria, it appears to belong to *Dipetalonema* group. Investigations are under progress to determine the vector of the infection. Table II shows the mosquitoes fed so far on the infected rats; none of them have shown any developmental stages.

TABLE II

Showing the dissection results of different species of mosquitoes fed on rat having filarial infection

Species of mosquitoes	Number dissected	Result
<i>Aedes aegypti</i> ..	200	All negat
<i>Aedes albopictus</i> ..	150	"
<i>A. stephensi</i> ..	255	"
<i>C. fatigans</i> ..	108	"

The ectoparasites (mites) collected from body of the rats have shown earlier stages of development of filarial infection. The results of the same are shown in Table III.

TABLE III

Showing the dissection results of mites collected from rat having filarial infection

Number dissected	Result
199	5 positive (second stage larva)

Attempts are also being made to recover the adult worm.

Successful transmission of this infection to other healthy domestic rats, after determination of the vector and the species of infection, will be of great help in the studies of experimental filariasis. Ramakrishnan *et al.* (1961) have successfully transmitted *L. carini* infection from cotton rats to albino rats, thereby maintenance of strain of infection has been made much easier. A strain of filarial infection maintained in domestic rats will be still easier if achieved successfully.

National Institute of S. PATTANAYAK.  
Communicable Diseases,  
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Calicut, May 5, 1964.

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#### EFFECTS OF DRENCHING WITH MAGNESIUM CARBONATE SUSPENSION ON THE BODY WEIGHT AND ON MAGNESIUM AND CHOLESTEROL CONTENT IN SERUM OF RABBITS RECEIVING BASAL DIET SUPPLEMENTED BY 15% GHEE

ADDITION of 10% ghee in a basal diet of the rats showed an elevation of serum cholesterol in comparison to 5%.<sup>1</sup> Again, either drenching with different magnesium salt solutions in rats<sup>2</sup> or injecting magnesium sulphate solution in rats<sup>3</sup> and rabbits<sup>4</sup> had depressing effects on the natural and induced serum hypercholesteremia.

In the present communication, the results are reported on the effects of drenching with magnesium carbonate suspension on the body weight and magnesium and cholesterol content in serum of rabbits fed with a basal diet supplemented by 15% ghee.

8 young rabbits (4 males and 4 females) between 800 to 1,000 g. live weight were divided

into 2 identical groups of 2 males and 2 females in each group. All the animals were fed with a basal diet consisting of crushed gram—65 parts, wheat bran—25 parts, skimmed-milk powder—7 parts, groundnut cake meal—2 parts and common salt—1 part. After 5 weeks, one group received the basal diet plus 15% ghee, prepared in the Institute Dairy Farm and another group on the same diet was drenched daily with 10% magnesium carbonate suspension in neutral distilled water at the rate of 2 c.c./kg. body weight. These treatments were continued for 4 weeks. Body weights were recorded weekly and the serum was analysed for magnesium<sup>5</sup> and total, ester and free cholesterol<sup>6</sup> before supplementing and at the end of the experimental period.

Group variations in the average body weight could not be recorded either during basal diet feeding period or during the treatments with ghee alone or with magnesium carbonate suspension. The composition of serum failed to show any group difference before treatments. In the drenched group, the magnesium and total ester and free cholesterol content in serum recorded 16% higher and 17, 14 and 21% lower respectively in comparison to ghee group (Table I).

TABLE I

Average values of the serum composition  
(mg./100 ml.)

	Basal diet	Basal diet 15% ghee	Basal diet 15% ghee MgCO <sub>3</sub>
Magnesium	2.8	3.0	3.6
Cholesterol:			
Total	157.0	262.0	217.0
Free	105.0	141.0	122.0
Ester	52.0	121.0	95.0

During the short period feeding experiment with 15% ghee a subclinical condition like hypercholesteremia in serum developed in the experimental animals. The elevated level could be successfully reduced by feeding them with magnesium carbonate.

The present findings have an important application in the public health problems especially in arterial diseases due to hypercholesteremia caused by the ingestion of milk products above the optimum level.

Animal Nutrition Div., N. K. BHATTACHARYYA,  
Indian Veterinary Res. D. N. MULLICK.\*

Institute, Izatnagar, U.P.,  
April 11, 1964.



\* Present address : National Dairy Research Institute,  
Karnal

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#### STRATIGRAPHICAL POSITION OF LIMESTONE BED AT LAITRYNGEW

DUTTA *et al.*<sup>1</sup> proved on the evidence of fossils that the limestone bed exposed in the Laitryngew (25° 19' 36" : 91° 44' 15") coalified is of Upper Cretaceous age; but due to lack of exposures they were unable to fix the exact position of the bed in the Cretaceous succession of Assam. Working near Mahadek (25° 13' : 91° 44' 30"), 10 miles south of Laitryngew, I was able last year to differentiate the lower Mahadek stage from the upper Langpar stage of the Cretaceous succession on the evidence of lithology and fossil content. The coarse Mahadek arkose is glauconitic near where it overlies the Sylhet Trap, about 704 feet thick, and near the top contains *Pyrina* sp., *Plicatula* sp., *Volutilithes* sp., *Turritella* sp., *Pecten* sp. and *Hemimaster* sp. The overlying greenish Langpar shale is mostly unfossiliferous except for a three-foot band of dark grey limestone which contains *Nautilus* sp., *Caryophyllia* sp., *Solarium* sp., *Trichotropis* sp. and *Baculites* sp. Ghosh<sup>2</sup> also records the occurrence of Nautiloids and *Baculites* sp., in the Langpar beds. The greyish white limestone bed exposed at Laitryngew was not met with the Langpar shales having been unconformably overlain by the Lower Eocene Cherra Sandstone.

West south-west of Laitryngew, near Mawsynram (25° 18' : 91° 34'), Palmer<sup>3</sup> records the occurrence of limestone (his Nummulitic Limestone) underlying coal-bearing sandstone and also of glauconitic Arkose of Mahadek age at Laitsohum (25° 16' 45" : 91° 34'), 2 miles south-west of Mawsynram. On examination of the sections this year it was found that the glauconitic Arkose of Laitsohum is overlain northwards on higher grounds by Langpar shales which, in turn, are succeeded by a limestone bed. This limestone bed is unconformably overlain by the coal-bearing sandstone. Fossils collected from this limestone show that

they are similar to those found in the Laitryngew Limestone bed. These are now being specifically determined.

These limestone beds would correspond to the top "Impure Earthy and Sandy Limestone" described by Ghosh<sup>4</sup> from the southern foothills of the Shillong Plateau. However, the limestone bed exposed at Laitryngew and Mawsynram are much purer, the Laitryngew one analysing 52-75% CaO.

The limestone bed is exposed between latitude 25° 18' (Mawsynram) and 25° 19' 36" (Laitryngew) but is not exposed at the latitude (25° 13') of Mahadek where the bed is missing due to erosion before the deposition of the Cherra Sandstone—a fact which leads to the conjecture that the Cretaceous formations were subjected to folding before erosion.

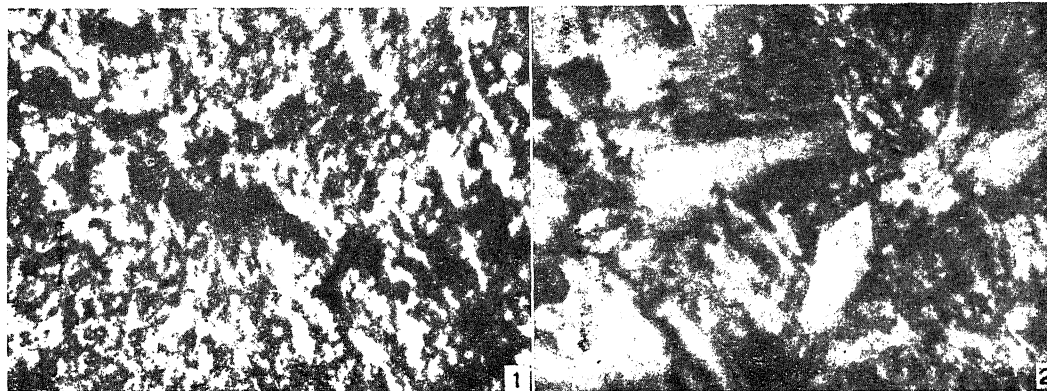
The writer is grateful to Dr. A. G. Jhingran, Director, Eastern Region, Geological Survey of India, for having the fossils identified at the Geological Survey of India Laboratory.

Government of Assam, T. C. BAGCHI.  
Directorate of Geology and Mining,  
April 22, 1964.

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#### ISOLATED OCCURRENCE OF TALC- ANTIGORITE SCHIST EAST OF DEOGARH, MEWAR (RAJASTHAN)

AN isolated lens-shaped outcrop of talc-antigorite schist occurs half a mile east of Deogarh (25° 32' : 73° 54') at the junction of the Delhi quartzites and the banded gneissic complex (Pre-Aravalli).<sup>1</sup> Parallel to the quartzites, runs a well-foliated epidote amphibolite sill, presumably a metamorphosed basic rock of the gneissic complex, very much traversed by thin pegmatite veins. A little further to the west of the junction, isolated lenticular masses of forsterite-diopside granulite are exposed in the vicinity of the mylonite bands.<sup>2</sup> A noteworthy feature of the junction zone is the profuse granite pegmatite activity, the pegmatites carrying well-developed tourmaline crystals in striking contrast to the pegmatites of the adjoining gneissic complex, which are devoid of tourmaline.<sup>3</sup> Invariably all the rock types of this narrow zone exhibit evidence of crushing and deformation,



FIGS. 1-2

The talc-antigorite schist is a bluish-green massive rock which is rather soapy to the touch. In thin sections antigorite occurs as extremely fine needles and plates interspersed with talc tending to a parallel arrangement imparting schistosity to the rock (Fig. 1). These tiny fibres and flakes, having an interlaced arrangement, tend at places to fan-like and feathery groupings in which schistosity is little apparent (Fig. 2). Finely divided magnetite is distributed as parallel streaks though it has collected into small octahedra here and there. A few xenomorphic granular quartz grains, relic grains of diopside and forsterite conspicuous by their high refractive index and bright polarisation colours, brown granular patches of calcite and long prisms of tremolite, are present in the schistose bands.

From the foregoing observations it is apparent that the talc-antigorite schist occurs in a zone of much crushing and dislocation and stress evidently played a leading role. The magnetite in the schist is possibly derived from the ferruginous impurity present in the original rock. Similar rocks like talc-serpentine-chlorite schists have been reported by late P. K. Ghosh from Southern Mewar.<sup>4</sup> Others<sup>5</sup> have referred to antigorite-talc schists as having derived from the regional metamorphism of basic rocks like gabbro or pyroxenite. The available field and microscopic evidence here suggests that the talc-antigorite schist, in all probability, is derived from the forsterite diopside granulite under the influence of dislocation metamorphism aided or accompanied by a considerable accession of water from the pegmatites.<sup>6</sup> These metamorphic changes roughly correspond to epidote amphibolite facies conditions<sup>7</sup> of regional metamorphism (400°-500° C.).

The author is indebted to Dr. S. Balakrishna for his guidance and suggestions.

Department of Geology, P. V. SOMAYAJULU.  
Osmania University,  
Hyderabad, April 27, 1964.

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#### NOTE ON THE HISTOLOGICAL STUDY OF THE LATERAL LINE SENSE- ORGANS OF *MYSTUS VITTATUS*

WALTER (1928) termed the neuromast organs present in the lateral line region of the fish as rheoreceptors. In *Mystus vittatus* the lateral line which is cutaneous in position extends in a straight line along the sides of the body up to the base of the caudal fin, while in the regions of the head, it lies beneath the skin and is thus subcutaneous in position. It lies in a closed canal and opens externally by a number of small pores situated almost at regular intervals.

The lateral line canal lies in the dermis or corium nearer to the epidermis. This canal contains a large number of sense-organs, the neuromasts (Fig. 1), and is protected by a discontinuous sheath of fibrous tissue only at the location of neuromast organs. In those regions where the neuromast is absent, the connective tissue fibres of the corium are closely applied to the canal wall, and there is no fibrous sheath.

Each neuromast is composed of two kinds of

cells: (i) Neuromast or sensory cells, (ii) Sustentacular or supporting cells.

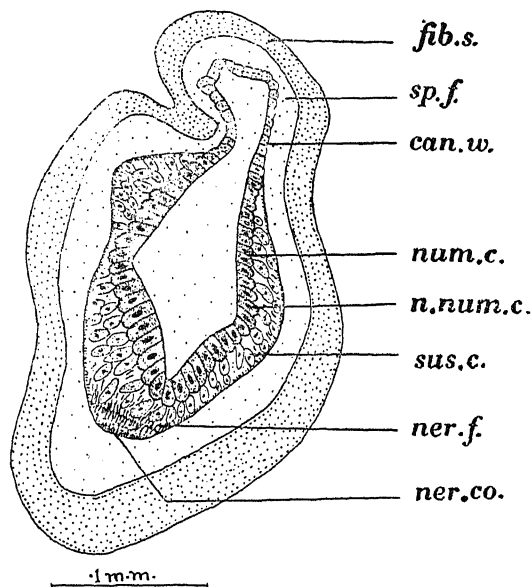


FIG. 1. V.S. of lateral line canal showing neuromast organ. (can.w., wall of the lateral line canal; fib.s., fibrous sheath; ner.co., nerve cord; ner.f., nerve fibre; n.num.c., nucleus of the neuromast cell; num.c., neuromast cell; sp.f., space between fibrous sheath and wall of the lateral line canal; sus.c., sustentacular cell.)

(i) *Neuromast cells*.—The cells of each neuromast are clearly marked off from the epithelium of the canal, for they may be as thick as four times, and are arranged in a single layer that may occupy nearly three-fourths of the circumference of the canal. In *Rita rita* (Bhatti, 1952) they occupy only half of it. These cells are longest in the middle region and diminish towards the sides. Each cell has a large nucleus in the centre. But Cole (1898) in *Gadus* and Bhatti (1952) in *Rita rita* have reported the nuclei in the upper and lower halves respectively.

Brockelbank (1925), Walter (1928) and others described the presence of free hairs projecting into the lumen of the canal at the free ends of the neuromast cells. These hairs are said to keep the fluid in the canal in motion. Such hairs, however, have not been observed in *Mystus*, they have also been not reported in *Rita rita* (Bhatti, 1952).

(ii) *Sustentacular cells*.—These cells are loosely situated below the sensory cells and occupy more space than the sensory cells. From the base of these cells start the nerve fibres, which join to form the nerve cord,

I am indebted to Dr. V. P. Agrawal for help and to Dr. O. P. Khandelwal for guidance.

Zoological Laboratories, V. K. RAJBANSHI.  
D.A.V. College,  
Muzaffarnagar (U.P.), March 30, 1964.

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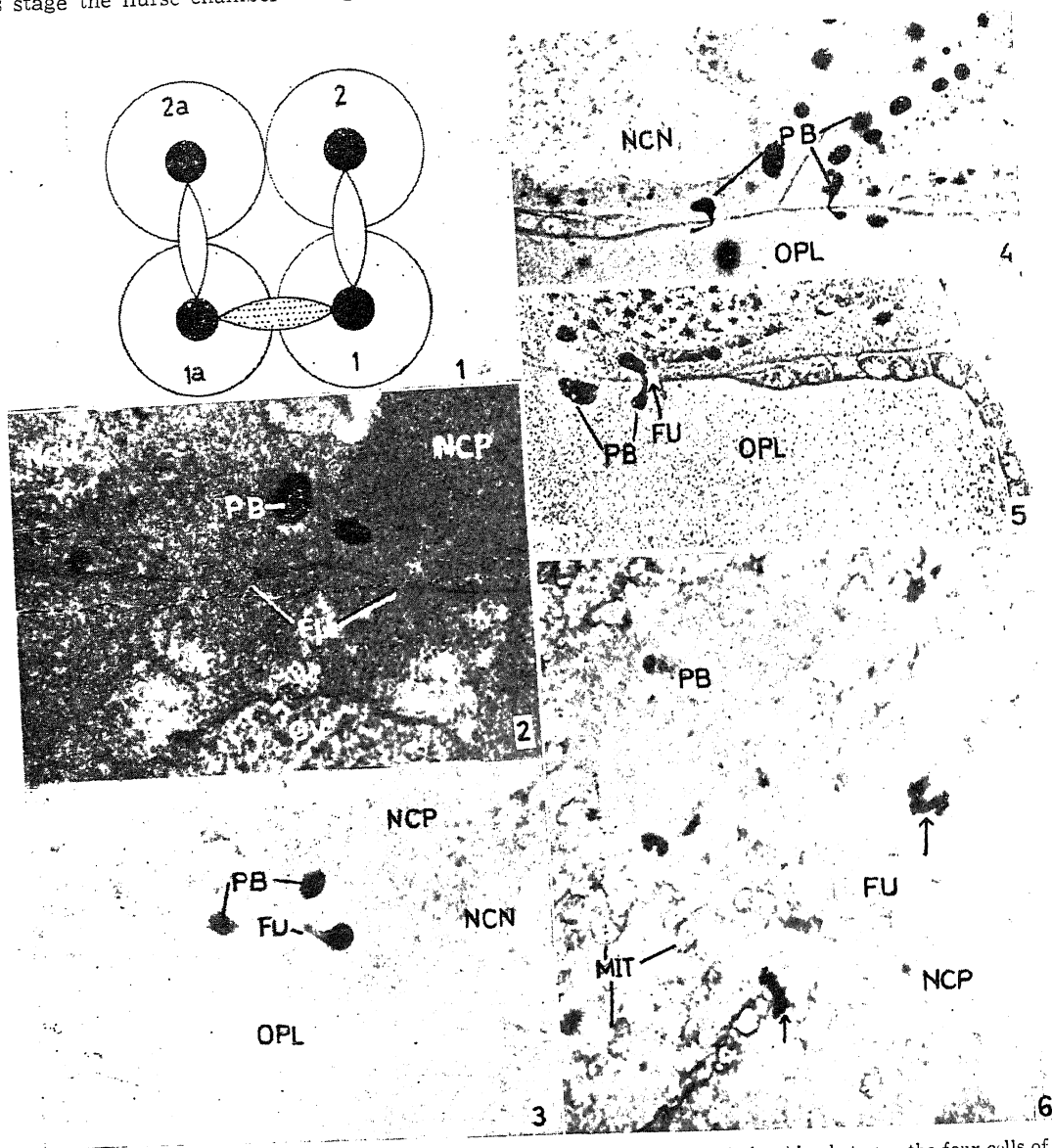
### INTERCELLULAR BRIDGES IN THE OVARIAN FOLLICLES OF *PANORPA COMMUNIS* L. (MECOPTERA—INSECTA)

RECENT autoradiographic and cytochemical studies<sup>1</sup> have shown that in the meroistic-polytroph ovarioles of the scorpion fly, *Panorpa*, the nurse cells supply the growing egg cell with RNA and cytoplasmic inclusions (protein bodies) through intercellular plasmatic bridges. An intercellular active transport of RNA is reported in the nurse cells of *Musca* and *Calliphora*.<sup>2</sup> In the telotroph type of ovarioles, the nurse cells remain in the apical chamber but are connected with the successive oocytes by means of several protoplasmic cords of varying lengths through which the supply of RNA is maintained,<sup>3</sup> whereas in the polytroph ovarioles, the nurse cells and the oocyte which result from oögonial mitotic divisions remain together enclosed in individual follicles of the vitellarium. The plasmatic connections between them is maintained through intercellular bridges which represent, according to Hirschler,<sup>4</sup> the remnants of mitotic spindle and are termed as "fusomes". King and Devine<sup>5</sup> described corresponding structures as "ring-canals". Meyer<sup>6</sup> applies the term fusome only to those intercellular bridges which possess a specific sealing device for closing the opening. This fusomal relationship between the nurse cells *inter se* as well as between nurse cells and the oocyte is investigated in the scorpion fly which is generally regarded as primitive holometabola.

The growth of the egg in *Panorpa* takes place in 12 vitellarial follicles of increasing sizes. In each follicle the egg cell is associated with a nurse chamber containing 3 cells which are arranged in such a way that each cell occupies a third of the cross-section. The three nurse cells are separated from one another as well as from the underlying oocyte by conspicuous cell membranes. In stage 7, the follicle epithe-

lium begins to grow between the nurse chamber and the oocyte as a double-layered shelf from either side, which, in stage 10-11, deepens to meet in the centre and closes the passage. At this stage the nurse chamber is degenerated.

The 3 nurse cells and one egg cell of each follicle result from 2 successive differential mitotic divisions of an oogonial cell. Assuming that the fusomes represent remnants of the mitotic spindle, the fusomal relationships bet-



FIGS. 1-6. Fig. 1. Schematic representation of the fusomal interrelationships between the four cells of a vitellinial follicle. Explanation in text. Fig. 2. Photomicrograph of a nurse chamber showing 2 nurse cells each with a fusomal opening into the oocyte. Carnoy/Masson's trichrome,  $\times 960$ . Fig. 3. Photomicrograph of a fusome between 2 nurse cells and a protein body squeezing through it. Helly/Azan,  $\times 900$ . Fig. 4. Photomicrograph showing the change of shape by two protein bodies as they pass into the oocyte. Susa/Iron haematoxylin,  $\times 490$ . Fig. 5. Photomicrograph showing the passage of a protein body through a distinctly visible fusome. Carnoy/Masson's (Goldner's Mfdn.),  $\times 490$ . Fig. 6. Electron photomicrograph of a fusome between 2 nurse cells corresponding to the one shown in Fig. 3. Note the osmiophilic secretory matter at the rim of the fusome and a protein body near it. Fixing and contrasting after Wolleath-Bottermann,  $\times 12,000$ . FU, fusome; GV, germinal vesicle; NCN, nurse cell nucleus; NCP, nurse cell plasma; OPL, ooplasm.

ween the four cells of a follicle are shown in Fig. 1. The stippled spindle is formed during the first mitotic division of the oogonium and the two unstippled spindles are formed during the second division. If the four resulting cells are numbered 1, 1a (first division), 2, 2a (second division) and if one of the lower cells (either 1 or 1a) differentiates into an oocyte, it can be connected by a fusome with a maximum of 2 nurse cells. The rest of the 3 cells will become nurse cells. The lower nurse cell is connected with the oocyte on the one hand and with the nurse cell above. Of the upper two nurse cells (2 and 2a), one is connected to the oocyte and the other is connected only with a nurse cell. But there is no fusome between the nurse cells 2 and 2a. Microscopic preparations bear out fully these assumptions. Figure 2 shows two fusomes between two nurse cells and the oocyte. Figure 3 shows the fusome between 2 nurse cells.

The fusomes appear as a break in the cell membrane whose edges are formed into ring-like thickenings on either side of the opening. The width of the fusome varies from 6 to 8  $\mu$ . The constancy of the position of the fusomes in the middle region of the membranes between the oocyte and the nurse cells supports the view of Hirschler that they are spindle remnants. Further the protein bodies form themselves into various shapes while passing through the fusomes (Figs. 4 and 5).

In *Panorpa*, however, none of the fusomes are visible before stage 7 in spite of very careful examination. This makes one suspect that they might be structures formed anew at that stage. If Hirschler's view of the origin of fusomes is correct, then they should be visible at all stages of the follicles. The visibility of the fusomes from stage 7 onwards coincides with the beginning of the flow of RNA and preformed protein bodies (the latter are strongly positive to bromophenolblue reaction for protein and to Bachmann and Seitz reaction for histidine) into the ooplasm. The invisibility of the fusomes until stage 7 both in light and electron microscopes can only be ascribed to a sealing mechanism reported by Meyer in *Drosophila*. A fusome in stage 8 between two nurse cells is shown in an electron microphotograph (Fig. 6). On account of the traces of osmiophilic secretory matter present at the edges of the ring, it may be inferred that in the earlier stages, the secretion was copious enough to have closed the opening and rendered it invisible. It is probable that the blocked fusomes might be opened by some

enzymatic action of the protein bodies that begin to pass through them from stage 7 onwards. The intercellular bridges of *Panorpa* can be regarded as fusomes in the sense of Meyer as they possess a sealing mechanism.

Department of Zoology, P. S. RAMAMURTY,  
Benares Hindu University,  
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### ON THE OCCURRENCE OF A HEME PIGMENT IN THE STOMACH OF THE AMPHIBIOUS SNAIL, *PILA GLOBOSA*

DURING the course of investigations on certain biochemical changes associated with aestivation in the amphibious snail, *Pila globosa*, it was found that the whole stomach in the aestivating snail is filled with a thick bright red viscous fluid. The present note deals with the finding of a heme pigment in this fluid.

Qualitative chemical tests,<sup>1</sup> given in Table I, were performed on aqueous extracts of the fluid in the stomach of aestivated snails for the detection of proteins, carbohydrates and uric acid. The presence of hematin pigment was tested by the Benzidine colour reaction.<sup>2</sup> Spectral absorption curves of 0.01 N HCl, 0.01 N NaOH and 0.1 M phosphate buffer (pH 7.4) extracts of the fluid were obtained with an ultraviolet spectrophotometer (Hilger and Watts, England) using 10 mm. silica cuvettes. Sodium dithionite was used to reduce the pigment in phosphate buffer extracts.

The qualitative colour tests (Table I) indicated the presence of proteins, non-reducing carbohydrates, uric acid and hematin and absence of  $\alpha$ -amino-acids and reducing sugars in the stomach fluid of aestivating *Pila*.

TABLE I

Biuret test	.. + + + +	Molisch test	.. + + + +
Millon's test	.. —	Fehling's test	.. —
Xanthoprotic test	+	Folin's uric acid test	++
Ninhydrin test	.. —	Benzidine test	.. + + +

(The number of + signs denotes the intensity of colour reaction.)

The presence of a heme pigment in the red viscous fluid of the stomach, as indicated by the Benzidine test, was confirmed by the in-

formation obtained from the spectral absorption curves, which showed a sharp absorption peak (the Soret or  $\gamma$ -band) at 413–415 m $\mu$  in the oxidized state and at 425–427 m $\mu$  when reduced with sodium dithionite. A sharp Soret band near about 400 m $\mu$  is characteristic of all porphyrin pigments.<sup>3</sup> On acidification the sharp absorption peaks characteristic of the reduced form disappeared, but reappeared again on the addition of alkali or dithionite.<sup>4</sup> Thus the results of the Benzidine test and spectral absorption analysis suggest the presence of heme type of pigment in the stomach fluid of the aestivating *Pila globosa*, contributing to the coloration of the fluid. The possibility of a carotenoid pigment also contributing to the colour of the stomach fluid has been eliminated, as the pigment could not be extracted, even in part, with fat solvents like petroleum ether and chloroform.

Similar occurrence of heme pigments in the gut of several molluscs and polychaetes has been reported.<sup>5</sup> Haemoproteins have also been isolated from the gut fluid of the snails, *Helix pomatia*<sup>4,6</sup> and *Euhadra*<sup>7</sup> and their origin has been traced to a group of cytochromes present in the hepatopancreas of these snails.<sup>4,8</sup> The spectral properties of the pigment in the stomach of *Pila* agree with those reported by Keilin<sup>4</sup> for helicorubin obtained from the gastro-intestinal fluid of *Helix pomatia*. This pigment is present in the active *Pila* also, but only in traces. A similar increase in the concentration of gut heme pigment during hibernation of *Helix pomatia* has been reported.<sup>5</sup>

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Department of Zoology,  
Sri Venkateswara Univ.,  
Tirupati (A.P.), India, May, 12, 1964.

S. RAGHUPATHIRAMIREDDY,  
KARUMURI S. SWAMI.

# EFFECT OF DEFOLIATION AT PANNICLE EMERGENCE ON GRAIN/ SPIKELET RATIO AND ON INDIVI- DUAL GRAIN WEIGHT IN RICE (*ORYZA SATIVA* L.)

THE contribution by various organs to the dry weight of grains at harvest has been shown by various workers (Watson and Norman, 1939; Porter, Pal and Martin, 1950; Enyi, 1962; and Thorne, 1963). The reduction in the dry weight of grain which may occur as a result of leaf-blade removal may be due to either low grain/spikelet ratio or low individual grain weight or both. Report presented in this paper deals with the effect of leaf removal at panicle emergence on grain/spikelet ratio and on the individual grain weight of two swamp rice varieties (BG. 79 and Black Paddy) and one upland rice variety (Agbede).

The plants were raised in local clay pots holding 28 kg. of soil. Three nitrogen treatments were applied to each rice variety [N1 = 2.0 g., N2 = 4.0 g. and N3 = 6.0 g. of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> per pot]. Each treatment was replicated four times. Each pot received a basic dressing of 2.0 g. of K<sub>2</sub>SO<sub>4</sub> and 4.0 g. of Ca(H<sub>2</sub>PO<sub>4</sub>)<sub>2</sub> and the pH of the soil was brought up to 6.0 by liming.

At panicle emergence the leaf-blades were removed with a pair of scissors and each plant surrounded by a wire cage to prevent birds from picking the seeds.

When the grains ripened, panicles of the main shoot and those of the first and second primary tillers of the plant in each pot were harvested. Records of the number of spikelets and grains for each pot were made and from the data obtained the ratios of grain/spikelet number were calculated as percentages.

The grains from each pot were dried separately in an electric drying oven maintained at a temperature of 90°C. for twenty-four hours and then weighed. The individual grain weight was calculated from the total grain weight. The results for the grain/spikelet % and the individual grain weight for each variety are summarised in Table I.

In all the varieties complete defoliation at the time of panicle emergence reduced the grain/spikelet %, the reduction being considerably greater in Black Paddy. With regard to individual grain weight defoliation had a significant adverse effect only in the swamp rice variety, Black Paddy. In the rice varieties BG. 79 and Agbede the reduction in the grain/spikelet % was quite small and indicated that the efficiency of the ear, leaf-sheath and peduncle in photo-

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TABLE I

Effect of defoliation on (a) grain/spikelet %

Treatments	Rice varieties		
	Black Paddy	Agbede	BG. 79
Plants defoliated	55†	93	93
Plants not defoliated	85†	97*	96*
L.S.D.			
P = ( ) 0.05 .....	9	3	3
P = 0.01 .....	12	..	..

\* Significant at P=0.05 † Significant at P=0.01

(b) Individual grains weight (mg./grain)

Treatments	Rice varieties		
	Black Paddy	Agbede	BG. 79
Plants defoliated	20	26	21
Plants not defoliated	22*	27	21
L.S.D.			
P=0.05 .....	1.2	Not Signi- ficant	Not Signi- ficant
P=0.01 .....	1.6	..	..

\* Significant at P=0.01.

synthetic activity was somehow increased in order to compensate for the absence of the leaf-blades more especially that of the flag leaf.

In these two varieties reduction in the total grain weight per panicle, which might have occurred as a result of defoliation, would be due mainly to the reduction in the grain/spikelet ratio.

At high nitrogen supply the ear, peduncle and leaf-sheath of the rice varieties studied tended to be greener than at low nitrogen supply and under this condition one would expect the photosynthetic efficiency of these organs to increase with increasing nitrogen supply especially when light was not a limiting factor. Medina and Leith (1963) found a positive correlation coefficient ( $r_d = +0.82$ ) between above-ground organic matter and its chlorophyll content. The results shown in Fig. 1 for the rice varieties,

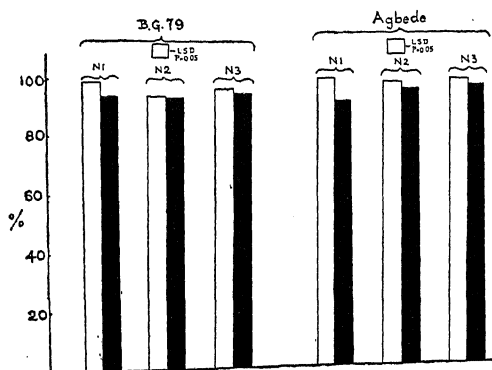


FIG. 1. Effect of varying nitrogen supply on grain/spikelet % of defoliated ■ and undefoliated □ rice plants.

BG. 79 and Agbede, indicated that the quality of chlorophyll present in the epidermis of the plant as indicated by the intensity of greenness would determine the extent to which defoliation would reduce the grain/spikelet ratio.

In Black Paddy the glumes and part of the leaf-sheaths and peduncle were covered with black pigments. This probably reduced the photosynthetic activity of these organs. It is not surprising, therefore, that defoliation reduced considerably both grain/spikelet ratio and the individual grain weight in this variety.

It may be concluded from these findings that the part played by the leaf-blade in contributing to the total grain weight at harvest will depend on the fertility of the soil and on the presence or absence of pigments in the ears, leaf-sheaths and peduncles.

College of Agriculture, B. A. C. ENYI.  
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#### INTERSPECIFIC HYBRIDIZATION IN BRASSICA—CROSSABILITY RELATIONSHIPS BETWEEN *B. TOURNEFORTII* AND SOME 20-CHROMOSOME SPECIES

THE cultivation of *Brassica Tournefortii* Gouan is said to extend from Tibet westwards to Italy and Spain. It is reported to have been cultivated in the past in the Punjab and in the semi-desert areas between Ajmer and Delhi. It has now gone out of cultivation, perhaps because there are other better oil-yielding *Brassica* species adapted to the Indian conditions. From the breeding point of view, however, it has a desirable character: It has a bushy compact habit with a number of shoots arising from the base of the plant at which the leaves form a rosette, the angle of branching of the fruiting shoots being narrow. The silique also do not spread much (Fig. 1). If this character of compact habit of *B. Tournefortii* could be incorporated into our oleiferous *Brassicæ* particularly to *B. campestris* var. *sarson* (yellow and brown *sarson*), *B. campestris* var. *toria* which are generally grown as pure crops, the number of plants per unit area could be greatly increased thereby increasing the acre yields.

*B. Tournefortii* resembles *B. campestris* L. var. *sarson* Prain in possessing occasionally a seed in the beak. It resembles *B. juncea* Coss. in having ribbed deaded silique. Its somatic chromosome number is 20 in common with the other species of the 'A' genome group of *Brassica* in which there are at least ten species. It is, therefore, natural to expect that *B. Tournefortii* also belongs to this genome group and crosses with the other 20 chromosome species which cross readily among themselves producing fertile hybrids. So crosses were made between *B. Tournefortii* and *B. campestris* var. *sarson* (yellow *sarson*), *B. chinensis* and *B. campestris* var. *toria*. Details of the crosses made and the hybrids obtained are given in Table I.

*B. chinensis* and *B. campestris* var. *sarson* and *B. rapa* (Srinivasachar, unpublished). To see whether it crosses with *B. Tournefortii* also, crosses were made both at the diploid and tetraploid level but with negative results. Mohammad and Sikka<sup>1</sup> also did not succeed in effecting this cross. Attempts were also made to cross *B. Tournefortii* with *B. juncea* and with *B. napus* which contain the 'A' genome but without any success.

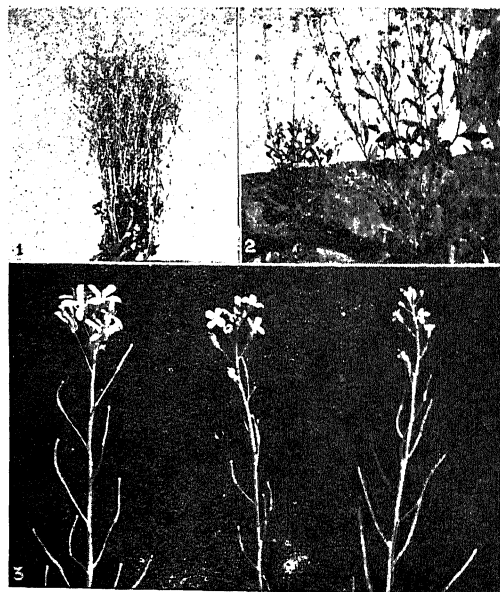
These results indicate that although *B. Tournefortii* crosses more readily with *B. chinensis* than with *B. campestris* var. *sarson* making gene exchange between them possible nevertheless it is a distinct species far removed from the other 20-chromosome species of *Brassica*. Its

TABLE I

Female parent	Male parent	No. of flowers pollinated	No. of seeds ob- tained	N. of seeds sown	No. of seedlings raised to maturity	No. of true hybrids
1. <i>B. Tournefortii</i> ( $2n=20$ )..	<i>B. campestris</i> var. <i>toria</i> ( $2n=20$ )	50	30	30	29	0
2. do.	.. <i>B. campestris</i> var. <i>sarson</i> ( $2n=20$ )	50	22	22	17	4
3. do.	.. <i>B. chinensis</i> ( $2n=20$ )	250	135	135	77	24

As could be seen from Table I, *B. Tournefortii* was successfully crossed with yellow *sarson* and *B. chinensis* indicating that they have something in common between them. It did not, however, cross with *toria*. Successful crossing of *B. Tournefortii* with yellow *sarson* has already been reported.<sup>4</sup> Olsson<sup>2</sup> did not succeed in crossing *B. Tournefortii* with *B. chinensis* and *B. campestris* L. var. *sarson* Prain nor did he succeed in crossing it with *B. campestris* var. *toria* (Duthire and Fuller), *B. campestris* var. *olcifer* Metz., *B. pekinensis* Rupr., *B. narinosa* Baily and *B. nipposinica*. The  $F_1$  hybrids did not possess the bushy compact habit of *B. Tournefortii* and resembled more the other parent (Fig. 2), indicating that this character is governed by recessive gene or genes. The hybrids were completely sterile (Fig. 3) and occasionally formed one or two seeds under open-pollinated conditions. With a view to raise amphidiploids, facilitating transference of the habit of *B. Tournefortii* to the other species, flower-buds of  $F_1$  *B. Tournefortii*  $\times$  *B. campestris* L. var. *sarson* were treated with 0.4% aqueous colchicine in glycerine and a few presumably doubled seeds were obtained.

*B. nigra* (comprising the 'B' genome of *Brassica*) crosses with *B. campestris* var. *toria*,<sup>3</sup>



FIGS. 1-3. Fig. 1. *B. Tournefortii*. Fig. 2.  $F_1$  *B. Tournefortii*  $\times$  *B. chinensis* (left) and *B. chinensis* parent (right). Fig. 3. Flowering branch of *B. campestris* var. *sarson* (left),  $F_1$  *B. campestris* var. *sarson*  $\times$  *B. Tournefortii* (middle), note sterility and *B. Tournefortii* (right).



radio sensitivity towards gamma and neutron rays (Srinivasachar, unpublished) also lends support to this view.

This work was done at the I.A.R.I. Centre of PIRRCOM under the aegis of the I.C.A.R. to whom my thanks are due.

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### TELIAL STAGE OF THE RUST ON *SESBANIA AEGYPTIACA* POIR

*Sesbania aegyptiaca* Poir is a shrubby plant, the pods and foliage of which are used as fodder and the plants are also grown as a wind-break in betelvine cultivation. A leaf rust inciting yellow infectious spots is of common occurrence and is so far known in the uredial stage only, under the name *Uredo sesbaniae* P. Henn. Previously the rust has been recorded from Manjri near Poona (Butler and Bisby<sup>1</sup>). The uredia are mostly hypophyllous borne on pale yellow infectious spots. The sori are reddish-brown scattered erumpent and pulverulent and naked after the spores are dispersed. Mature spores are ovate to spherical, cinnamon yellow with 2-4 equatorial germ pores. The wall of the spores is thin and minutely and densely verrucose. The spores measure  $17-26 \times 13-21 \mu$ . The rust resembles in all respects the description of *Uredo sesbaniae*.

In the present studies the telial stage was collected by the senior author in the month of February, 1962. Examination of old rusted leaves for possible occurrence of the perfect stage gave fruitful results. In some of the old uredo sori, the telial spores were found developing from the same sorus plexus. Mature telial spores are one-celled and are typical of *Uromyces* sp. In a general way the telial spores resemble some of the *Uromyces* sp. on Leguminosae, but are distinct from others in spore measurements, sculpturing of the spore wall, etc. The telial stage having been found in the present study, the rust has to be transferred to *Uromyces*. Since Henn's material is based upon uredial stage only and does not have the telial

stage, it is proposed to present the rust with a new name *Uromyces poonensis* with the following description :

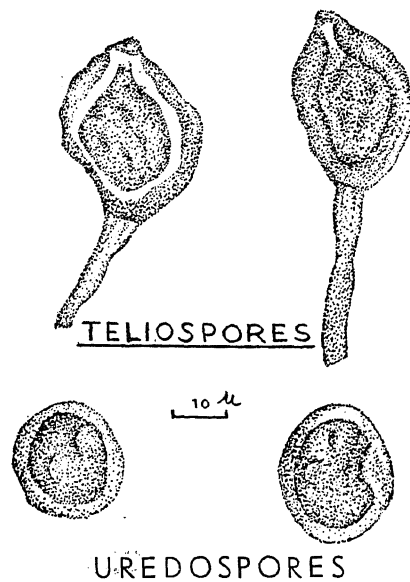


FIG. 1

*Uromyces poonensis* More and Moniz nom. nov.  
Sym. *Uredo sesbaniae* P. Henn.

Uredia in foliis; infectionis maculae pallide luteae, diffusae; sori rubro-brunnei, dispersi, erumpentes atque pulverulenti, nudi post erumpentiam, subepidermales, aparaphysati; uredosporae pedicellatae, ex ovatis sphaericae, cinnamomo-brunneae, poris germinalibus 2-4 aequatorialibus, parietibus minute et dense verrucosis,  $17-26 \times 13-21 \mu$ .

Teliosporae cum urediis mixtae, pedicellatae, castaneo-brunneae, subglobosae vel obpyriformes, saepe angulares, parietibus ad apicem  $3.5-6 \mu$  crassis, indistincte verrucosis, umbonatis,  $21-32 \times 14-23 \mu$ ; pedicelli hyalini decidui, ad  $26 \mu$  longi in foliis *Sesbaniae aegyptiacae* Poir W. D. More, Poona Agric. Coll. 8-2-1962, No. 101, Typus positus in Herb. Crypt. Ind. Orient., New Delhi.

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# THE INTERRELATIONSHIP BETWEEN POLYPLOIDY, ALTITUDE AND CHEMICAL COMPOSITION IN *ACORUS CALAMUS*

THE rhizomes of *Acorus calamus* L., the Sweet flag, has been employed in medicinal preparations and as a flavouring agent, from ancient times. It is a polymorphic species distributed in the North Temperate Zone. The Jammu variety has attracted attention in India recently as an insecticide because of its high asarone content (Chopra *et al.*, 1958).

When Chowdhuri, Gautam and Handa (1957) made a comparative study of calamus oil from the rhizomes collected in Jammu and Kashmir they found the Jammu oil was heavier than water while the specific gravity of the Kashmir oil was only 0.97. The Kashmir oil is nearer the European oil in this respect than that from the plains of India. A further difference between the Jammu and the Kashmir Calamus oils was in the percentage of asarone, which was only 5.2% in the Kashmir and over 80% in the Jammu oil. Handa repeated these experiments in 1963 and observed higher camphor and calamene content in the Kashmir form as given in Table I.

TABLE I

	Jammu oil	Kashmir oil
Yield	3.1%	1.4%
Sp. gravity at 15°	1.05.1	0.9710
Refractives index at 15° C.	1.5540	1.5036
Optical rotation at 15° C.	+20	+140
Solubility in 90% alcohol	mixable	mixable
Acid value	0.14	2.24
Ester value	18.2	58
Pinine $\alpha$	..	0.40%
Pinine $\beta$	..	0.56%
Calamine	..	3.84%
Calmol	..	3.2%
Asarone	..	77.12

The Jammu and the Kashmir races of *Acorus* which are now being grown in the Ramnath Chopra Garden of Medicinal Plants, Regional Research Laboratory, Jammu, were examined cytologically. The Jammu plant had 36 chromosomes and is similar both cytologically and chemically to plants collected in Mukerian and Dasuya in the Punjab, while the Kashmir form had 54 chromosomes. The lowest chromosome number reported for *A. calamus* is  $2n=18$  by Matsuura and Sato (1935). The Jammu Plant is thus a tetraploid  $2n=36=4x$  and the Kashmir a hexaploid  $2n=54=6x$ . This is also the highest chromosome number reported for the genus.

It is interesting to note that the asarone content is higher in the tetraploids than in the hexaploids. The tetraploid race has also been shown to have higher oil content than the diploid or triploid (Wulff, 1954). Thus tetraploid plants in *Acorus* possess the maximum capacity for the development of oil. However, it will be seen from Table I that the calamine and camphor content is higher in the hexaploids than in the tetraploids. This is interesting because in India these hexaploids are confined to the higher altitude of Kashmir.

Thus there seems to be a correlation between chromosome number, altitude and chemical composition in *Acorus calamus*.

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## A NEW VARIETY OF *SMILAX GRIFFITHII* A. DC. FROM N.E.F.A. (INDIA)

THIS note describes a new variety of *Smilax griffithii* A. DC. var. *borii* Panigr. et Naik, var. nov., collected from the Kameng Frontier Division, N.E.F.A., and confirmed at the Herb., Kew, England. Although Hooker in *Fl. Brit. India*, 6, 313, attributes 7-umbelled male panicles to *S. griffithii* A. DC. the type specimen, viz., Griffith 5444 from Assam, examined at Kew Herbarium, is generally 8-umbelled; some specimens having even 9 umbels are seen.

*Smilax griffithii* A. DC. var. *borii* PANIGR. et  
NAIK, var. nov.

Accedit ad varietatem typicam a qua tamen recedit pedunculis et pedicellis longioribus, staminibus sepala æquantibus.

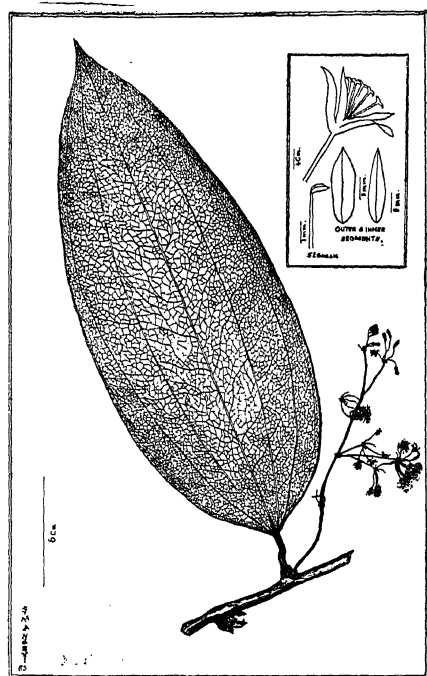
Rami obtuse angulares, leniter sulcati, leves. Folia ovata vel ovato-lanceolata, 18-28 × 10 cm., 7-nerviæ ex acuta basi, breviter acuminata ad apicem, glabra; petiolus 15-25 mm. invaginans infra medium, vagina auriculis parvis magnisve ornata. Umbellæ masculæ 6-11, paniculatæ, ternatæ vel alternæ in rachide axillari ca. 8-10 cm. longa. Pedunculi 3 cm. attingentes;

pedicelli ca. 7 mm. Bracteae ad basin paniculae ovatae, ca. 6 mm. longae; bracteolae ovate, minutae. Flores castaneo-brunnei. Alabastra clavata. Perianthii segmenta externa obovata ad apicem acuta, ca.  $6 \times 1.5$  mm.; interiora vero lanceolata,  $6 \times 1$  mm., omnia uninervia, patentia vel reflexa sub flore. Stamina 6, aequae longa ac segmenta. Anthera ovata filamentum longo complanato insidens. Flores feminei haud visi.

Typus lectus ad Sissini in Kameng Frontier Division, N.E.F.A., die 27 March, anni 1957 ab auctore seniore et positus in herbario sectionis orientalis Bot. Surv. Ind. numero *Panigrahi* 6146 ad Shillong; paratypus, *Bor* 1644 lect. in collibus Aka dictis mens junio anni 1934 et positus in eodem herbario.

*Smilax griffithii* A. DC. var. *borii* PANIGR. et  
NAIK, var. NOV.

This variety resembles *S. griffithii* A. DC. in having leaves 5-7 costate, costae arising from the base of the leaf, but it differs from the type variety in having panicles with longer peduncles (1.5-3.8 cm.) and longer pedicels (8-9 mm.) and stamens as long as the sepals (cf. *S. griffithii* A. DC. is characterised by stamens slightly smaller than the sepals).



*Smilax griffithii* A. DC. var. *borii* Panigr. et Naik var. nov.

Branches obtusely angular, faintly grooved, smooth. Leaves ovate or ovate-lanceolate,

18-28  $\times$  10 cm., 7-nerved from the acute base, shortly acuminate at apex, glabrous on both surfaces. Petiole 15-25 mm., sheathing below the middle, sheaths with small or large auricles. Male umbels 6-11, panicle, 3-nate or alternate on an axillary rachis which is about 8-10 cm. long. Peduncles of the umbels reaching 3 cm. in length; pedicels about 7 mm. Bracts at the base of the panicles ovate, about 6 mm. long; bracteoles ovate, minute. Flowers (and the whole inflorescence) chocolate-brown. Buds clavate. Outer perianth segments obovate, acute at apex, about  $6 \times 1.5$  mm.; inner ones lanceolate, about  $6 \times 1$  mm.; all 1-nerved, spreading or reflexed in flowers. Stamens 6, as long as segments. Anther ovate on a long flat filament. Female flowers not seen.

The type was collected from Sissini (about 1200 m.) in Kameng Frontier Division, N.E.F.A., on March 27, 1957, by the senior author and the type sheet (*Panigrahi* 6146) is located in the herbarium of Eastern Circle, Botanical Survey of India, Shillong, and the paratype (*Bor* 1644) collected from the Aka hills without precise locality in June 1934, is also deposited in the same herbarium.

We are grateful to Dr. H. Santapau, Director, Botanical Survey of India, Calcutta, for kindly giving the Latin diagnosis and to the Director, Royal Botanic Gardens, Kew, for the help rendered in this connection.

Botanical Survey of India,  
Central Circle, Allahabad,  
April 23, 1964.

G. PANIGRAHI.  
V. N. NAIK.

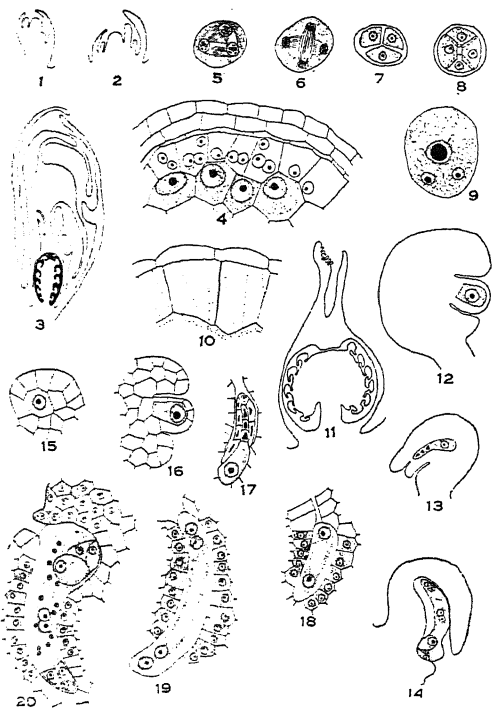
## A CONTRIBUTION TO THE EMBRYOLOGY OF *UTRICULARIA* *EXOLETA* R. BR.

THE family Lentibulariaceae displays interesting features for embryological investigation. Significant contributions have been made by Wylie and Yacom (1923), Kausik (1938), Khan (1954) and Kausik and Raju (1955).

The present communication deals with some aspects of floral morphology and embryology of *Utricularia exoleta*.

Material for the present study was collected round about Bangalore. Its determination was kindly checked by the systematic Botanist, Botanical Survey of India, Coimbatore. The inflorescence and flower-buds were fixed in F.A.A., dehydrated and embedded in paraffin wax. Sections were cut at 8-12  $\mu$  and stained in Heidenhain's hematoxylin.

Calyx initials are the first to develop followed by those of carpel, androecium and corolla (Figs. 1-2). Figure 3 represents the longitudinal section of a young flower bud showing the disposition of the different floral parts.



FIGS. 1-20. Figs. 1-2. Development of floral parts in acropetal succession,  $\times 2,400$ . Fig. 3. L.S. of young flower-bud,  $\times 120$ . Fig. 4. A portion of an anther lobe showing epidermis, endothecium, middle layer, bi-end tri-nucleate tapetal cells and sporogenous cells,  $\times 2,400$ . Figs. 5-8. Tetrahedral and decussate arrangement of microspores,  $\times 3,000$ . Fig. 9. Mature pollen grains showing three celled condition,  $\times 3,000$ . Fig. 10. Part of a mature anther with fibrillar, endothecium,  $\times 2,400$ . Fig. 11. L.S. of the ovary showing the anatropous ovules,  $\times 2,400$ . Figs. 12-14. Progressive stages in the development of ovules, Fig. 12.  $\times 2,400$ , Figs. 13-14.  $\times 1,580$ . Fig. 15. Hypodermal archesporial cell,  $\times 2,400$ . Fig. 16. Megaspore mother cell,  $\times 2,000$ . Fig. 17. Linear tetrad of megaspores,  $\times 2,400$ . Figs. 18-20. Stages in the development of embryo-sac,  $\times 2,400$ .

The transverse section of the young anther lobe shows epidermis, endothecium, a middle layer and tapetum. The tapetal cells are uninucleate in the beginning and later become bi- and tri-nucleate (Fig. 4). Pollen mother cells by meiotic divisions give rise to tetrads of microspores, which are mostly tetrahedral but occasionally decussate in arrangement (Figs. 5-8). The pollen grains develop thick smooth exine and thin intine and are triplicate. The pollen grains

are three-celled (Fig. 9). The anther wall at the time of dehiscence has only epidermis and endothecium. The cells of the endothecium exhibit fibrillar thickenings (Fig. 10).

The ovary is superior, bi-carpellary, with indefinite number of anatropous, unitegmic, tenuinucellate ovules arranged all over the central placenta except at the apex (Fig. 11).

The ovules at first arise as conical outgrowths, and finally become anatropous, owing to the pronounced growth of the funiculus on one side (Figs. 12-14).

The hypodermal archesporial cell differentiates in the nucellar primordium and directly functions as the megaspore mother cell (Figs. 15-16). The megaspore mother cell undergoes the usual meiotic divisions to form a linear tetrad (Fig. 17). The nucleus of the functioning chalazal megaspore, by three successive divisions, develops into an eight-nucleate embryo-sac of the polygonum type (Figs. 18-20). During early stages of development, the embryo-sac remains intraovular. At the eight-nucleate stage, the micropylar end of the embryo-sac grows out of the micropyle and comes in direct contact with placental nutritive tissue. The mature embryo-sac is curved and contains starch grains. The nucellus becomes disorganised and, the embryo-sac comes in direct contact with the integument. The cells of the integument immediately surrounding the embryo-sac contain prominent nuclei and rich cytoplasm, and form the integumentary tapetum.

*Utricularia exoleta* displays similarities and differences with the allied species in the following features:

1. Pollen grains are three-celled as in *Utricularia coerulea* and *Utricularia reticulata*, but differs from *Utricularia flexuosa*, there they are three-nucleate.

2. Central placenta is globular as in *Utricularia coerulea* and *Utricularia flexuosa* and not flattened as in *Utricularia reticulata*.

3. The micropylar end of the embryo-sac in *Utricularia exoleta* becomes extraovular as in *Utricularia coerulea* and *Utricularia flexuosa*. This differs from the condition reported in *Utricularia reticulata*.

My thanks are due to Prof. S. Shamanna and Rev. Fr. C. Seldana, S.J., for their valuable suggestions and help. My thanks are also due to Rev. Fr. E. D'Souza, S.J., Principal, St. Joseph's College, Bangalore, for his encouragement.

Department of Botany,  
St. Joseph's College,

G. SHIVARAMIAH.

Bangalore-1, May 16, 1964.

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#### PELLICULARIA LEAF-SPOT OF *RAUWOLFIA SERPENTINA* UNDER CULTIVATION

DURING October 1963, a large-scale leaf-spot infection was noted in one of the experimental fields where *Rauwolfia serpentina* is being grown in Ranoli.\* The plants were heavily shaded by Castor (*Ricinus communis*) and the atmospheric humidity was high owing to late South-West Monsoon. *Rauwolfia serpentina* plants situated in densely shaded areas were more affected than those in relatively open areas. The different stages of leaf-spots are presented in Fig. 1.

was a halo around each spot usually as wide as its diameter. Occasionally, infection occurred even on floral parts.

A cross-section of the infected portion of the leaf revealed complete disintegration of the chlorenchymatous tissue and the dark brown fungal mycelium ramifying through the intercellular spaces. The mycelium was colourless when young, turned dark brown as they grew older and formed many strands on the leaf surface. Numerous sclerotia were found scattered among the dark brown hyphæ. Many sections showed the hyphal ends bearing groups of basidia. Four ellipsoid basidiospores, pale green in colour, were borne individually on sterigmata arising from the top of each basidium.

The halo around the infected spot showed strands of newly formed and colourless fungal hyphæ among the intercellular spaces of the parenchyma which had successive stages of disintegration of the chloroplasts, presumably due to liberation of fungal toxins on the host tissue.

Detailed study of the hyphæ, sclerotia and the

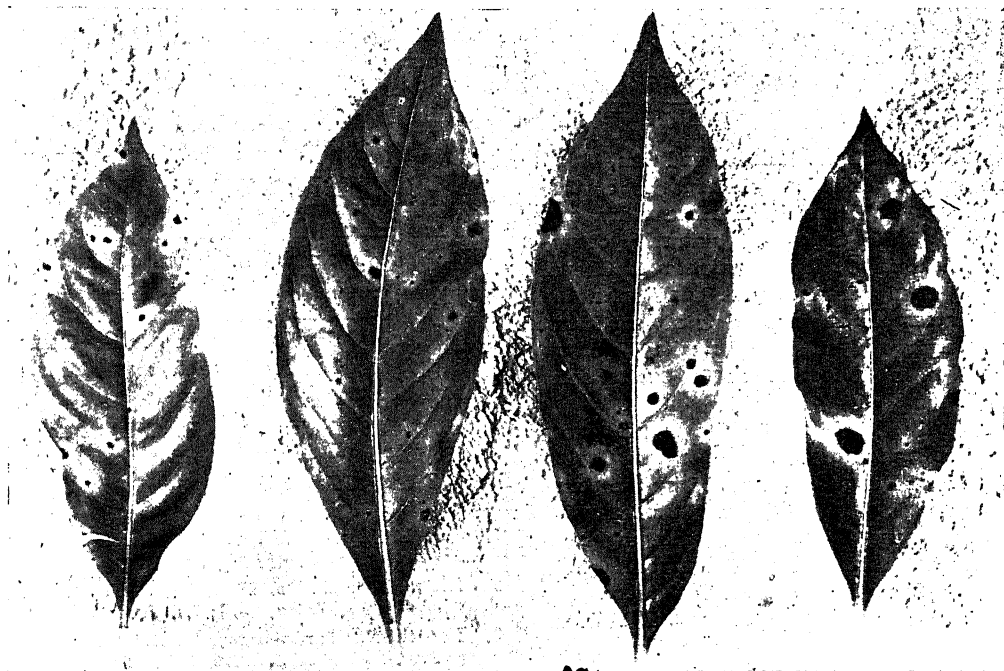


FIG. 1. Showing the successive stages of leaf-spot infection of *Rauwolfia serpentina* Benth. caused by *Pellicularia filamentosa* (Pat) Rogers.

The spots appear on the upper surface of the lamina as pin-points and enlarge upto 8–10 mm. in diameter in about a month's time. There

reproductive parts confirmed the identity of the fungal pathogen as *Pellicularia filamentosa* (Pat) Rogers.<sup>1-3</sup> The present report is the first

record of *Pellicularia filamentosa* on *Rauwolfia serpentina*.

Portions of lamina including the diseased spot were surface-sterilised and plated out on acidified potato dextrose agar and in all cases the fungal pathogen was isolated. The cultures were purified and further work is in progress which will be published elsewhere.

The author thanks Dr. V. Srinivasan, Director, for his keen interest and the management for permission to publish this note.

Division of Botany, P. D. VARADARAJAN.  
Sarabhai Chemicals

Research Institute,  
Ahmedabad-4, May 6, 1964.

\* Ranoli is situated 8 miles north of Baroda, Gujarat State, India.

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#### INDUCED POLYPLOIDY IN *ORYZA OFFICINALIS* WALL. EX WATT. AND *O. AUSTRALIENSIS* DOMIN.

ALTHOUGH induced autotetraploids were reported in cultivated rices, *Oryza sativa* L. (Cua, 1952) and *O. glaberrima* Steud. (Hinata and Oka, 1961), no such reports exist in wild species of the genus. However, Ramiah, Parthasarathy and Ramanujam (1935) reported a naturally occurring tetraploid in *O. longistaminata* A. Cheval et Roehr. The present report deals with the successful attempts on induced tetraploid in an intervarietal hybrid of *O. officinalis* Wall. ex Watt. and in a collection of *O. australiensis* Domin.

A semisterile  $F_2$  plant out of a natural cross between a collection of *O. officinalis* from Ceylon and another of Bangkok (supplied by the courtesy of Shri S. Sampath) was treated with colchicine. Young lateral buds emerging from the stem were soaked for 9 hours in 0.02% aqueous colchicine solution, washed thoroughly and planted in soil. Out of several buds so treated, one survived to maturity and produced

diploid and tetraploid sectors which differed sharply in morphology as in Table I.

Autotetraploid form of *O. australiensis* was secured by the treatment of young seedlings. Seedlings with plumule of about 1 cm. long were soaked for 6 to 12 hours in aqueous solution of colchicine of concentrations of 0.01% and 0.02%. Of the ten different accessions of

TABLE I

Character	Diploid Sector	Tetraploid Sector
Culm	.. Thin	Thick
Breadth of leaf	.. 1.75 cm.	2.1 cm.
Ligule	.. 0.4 cm.	0.7 cm.
		sparsely hairy
Leaf-sheath fringing	.. Not fringed	Fringed
Length of panicle	.. 28 cm.	40 cm.
Grain size (L+B)	.. 5.7 mm./2.5 mm.	7.0 mm./2.8 mm.
Tip of palea	.. Normal	Tipped 0.7 cm.
Fertility of spikelets	.. 52%	77%

this species so treated, in a single accession (our No. 430) and with the treatment of 0.01% colchicine for 9 hours, tetraploid sector was obtained. Tetraploid sector was clearly distinguishable by dark green foliage, stouter foliar veins; darker anthocyanin pigmentation in leaf-sheath, larger spikelets, more pronounced pedicellar lobes and elongated tip of the palea. Both the tetraploid forms described above exhibit quadrivalents and bivalents at metaphase I of meiosis.

We are grateful to Dr. B. P. Pal, Director, and to Dr. M. S. Swaminathan, Head of the Division of Botany, Indian Agricultural Research Institute, New Delhi, for their interest in the work. We are also thankful to Shri S. Sampath, Cytogeneticist, Central Rice Research Institute, Cuttack, for supplying the material.

Botanical Sub-Station R. GOPALAKRISHNAN.  
of I.A.R.I., S. V. S. SHASTRY.  
Pusa (Bihar), May 4, 1964.

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## REVIEWS

**The Mechanical Investigations of Leonardo Da Vinci.** By Ivor B. Hart. (Published by the California University Press; Agents: Cambridge University Press), 1963. Pp. xi + 240. Price 17 sh.

A book by Dr. Hart having the same title was published in the year 1925. Its purpose was to present in the English language a readable account of a particular phase of the activities of that amazing man whose character and attainments have been summarised by one writer recently in the following words: "Every once in a while, the Great Sculptor designs a model of the superman He is to create in the future. Leonardo was one of the most perfect of these divine experiments in human clay." Dr. Hart's book as originally published admirably fulfilled its purpose and placed before the reader a fascinating account of Leonardo's studies of bird flight and of his efforts to pioneer human aviation. The two chapters dealing with these matters were prefaced by others of an introductory nature picturing the general background of Leonardo's time, viz., the latter half of the fifteenth century and the earliest part of the sixteenth, and by two chapters containing an account of Leonardo's work in the field of general mechanics.

The book as now republished contains some additional matter, viz., a foreword by Professor Earnest A. Moody, and a second and rather lengthy introduction by Dr. Ivor Hart. These may conceivably be of interest to those who wish to delve into the dusty archives of the past and trace the history of the development of scientific ideas in Europe during the Middle Ages. But the reviewer feels that they do not really add to the value or usefulness of the book, at least from the point of view of the general reader interested in Leonardo and his achievements.

C. V. R.

**Advances in Astronomy and Astrophysics** (Vol. 2). Edited by Zdanek Kopal. (Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y., U.S.A.), 1963. Pp. 314. Price \$11.50.

The present volume is the second of a series, the aim of which is to present current studies in astronomy and astrophysics in their proper perspective as an integral part of the physical and mathematical sciences. It contains the

undermentioned contributions: The Twilight Zone of Venus by J. B. Edson, Cataclysmic Variables as Binary Stars by R. P. Kraft, Eclipse Phenomena by F. Link, White Dwarfs by W. J. Luyten, The Stray Bodies in the Solar System, Pt. I Survival of Cometary Nuclei and the Asteroids by E. J. Opik and Recent Developments in Studies of the Magellanic Clouds by A. D. Thackeray.

The memoir on Eclipse Phenomena by F. Link occupies nearly a third of the whole volume. This is a subject in which the author has engaged himself for more than a quarter of a century and has published numerous contributions. It contains a particularly elaborate discussion of the phenomena observed during an eclipse of the moon under twenty different heads. Eclipses of artificial and other satellites, the transits of planets, the occultations of stars by planets and eclipse phenomena are other topics dealt with in the same memoir.

C. V. R.

**An Introduction to Atmospheric Physics.** By Robert G. Fleagle and Joost A. Businger. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xi + 346. Price \$12.00.

This book is intended as a course for upper division and beginning graduate students in the atmospheric sciences. Although an understanding of the calculus and of the principles of physics is assumed, these fundamentals are restated where they are relevant; and the book is self-contained for the most part. The whole subject is handled under seven chapters, viz., (I) Gravitational Effects, (II) Properties of Atmospheric Gases, (III) Properties and Behaviour of Cloud Particles, (IV) Solar and Terrestrial Radiation, (V) Transfer Processes and Applications, (VI) Geomagnetic Phenomena and (VII) Atmospheric Signal Phenomena. The reviewer feels that one who has read the book and worked out the problems given at the end of each chapter will adequately be prepared for advanced studies in the field of meteorology, geomagnetism, etc. At the end of each chapter, general references are given which will direct the student to enable him to proceed to such advanced studies.

C. V. R.

**Introduction to Practical Infra-Red Spectroscopy** (2nd Edition). By A. D. Cross. (Butterworth and Co., 4 and 5 Bell Yard, London, W.C. 2), 1964. Pp. viii + 86. Price 17 sh. 6 d.

The first edition of this little book appeared at the end of 1959. The fact that a second edition is called for is an indication of the widespread interest felt in the subject of infra-red spectroscopy as also of the usefulness of the first edition. The book contains the essential material which every one concerned with the subject must be familiar with. It is a helpful introduction to the field and alike would be welcomed both by students and research workers. The second edition incorporates the changes and addition necessary in view of current advances in the field.

**Digital Computer Design—Logic, Circuitry and Synthesis.** By Edward L. Braun. (Academic Press, New York), 1963. Pp. xiii + 606. Price \$16.50.

Written by an author who has had considerable experience in designing digital computers and data processing for a variety of industrial, commercial and military applications, this book will be found suitable for instructional purposes to engineering students undergoing a course in computer designs. The aim of the author is to present the fundamentals essential to an understanding of the design and capabilities of digital computing machines. As the sub-title indicates the emphasis is on the functional approach, i.e., "in terms of how elements with defined input-output characteristics may be organized to synthesize subsystems or systems with specified functional capabilities".

The fundamental principles are dealt with in the first few chapters which include one on Boolean algebra. Each major chapter deals in a self-contained manner with a particular area of importance such as sequential switching networks, current switching and storage elements, large capacity storage systems, digital differential analyser, detection and correction of errors. The chapter on system design of GP (integral transfer) computers includes a detailed explanation of the logical designs of a GP computer with a static main store, and one with a dynamic main store.

Besides engineering students, the book will also be useful as a review and reference text to electronic engineers actually engaged in computer problems. At the end of each chapter extensive literature references are given.

A. S. G.

**Advances in Inorganic Chemistry and Radiochemistry**, Vol. 3 (1961) and Vol. 4 (1962). Edited by H. J. Emelius and A. G. Sharpe: (Academic Press, Inc., New York.) Pp. ix + 463 and viii + 344. Price \$12.50 and \$11.00.

These are the third and fourth volumes in this series of books published since 1959, and fulfil admirably the role of reviewing the fields of current interest in Inorganic and Radiochemistry.

The third volume contains eight review articles. The first article on Mechanisms of Substitution Reactions of Metal Complexes by F. Basolo and R. G. Pearson emphasizes the advances made in this field since the publication of the book in 1958 on the same subject by these authors. The articles on Molecular Complexes of Halogens by L. J. Andrews and R. M. Keefer, and on Structures of Interhalogen Compounds and Polyhalides by E. H. Wiebenga, E. E. Havinga and K. H. Boswijk though largely descriptive cover in a lucid manner, a very old and useful branch of Inorganic Chemistry. The very rapidly advancing field of radiation chemistry is represented by C. Ferradini in his article on Kinetic Behaviour of the Radiolysis Products of Water. Silanes and Their Derivatives are described by A. G. MacDiarmid in a short-balanced review. The General, Selective and Specific Formation of Complexes by Metallic Ions is reviewed in a masterly manner by G. Schwarzenbach. R. E. Banks and R. N. Hazeldine in their article on Polyfluoroalkyl Derivatives of Metalloids and Non-metals have critically reviewed the work done in this field of technological interest which has rapidly developed since the last world war. The authors have rightly pointed out that a great deal of physico-inorganic works awaits development for a better understanding of this subject. A. G. Maddock and E. H. Willis in the course of a rather short review cover the field of Atmospheric Activities and Dating Procedures. This article would be read with interest by not only the radiochemists but would be of general interest to all chemists.

The fourth volume has six review articles. E. Thilo summarises the work done on Condensed Phosphates and Arsenates a field which originated more than 100 years ago and is an example of how descriptive Inorganic Chemistry can be integrated with the physical approach to structure and kinetics. R. B. Guy and B. L. Shaw give a great deal of information on the nature of bonding between unsaturated hydrocarbons and transition metal atoms and how it has led to a better understanding of the role



of metallic catalysts in chemical reactions. J. R. Miller's article on the stereochemistry of Nickel, Palladium and Platinum, underlines the role of Ligand Field Theory in explaining the electronic spectra and magnetic measurements. The chemistry of Polonium is described in adequate detail by K. W. Bagnall. The subject of oxide melts which has rapidly developed in the last two decades, is reviewed by J. D. Mackenzie. Use of NMR spectroscopy in Inorganic Chemistry has been reviewed in a critical manner by E. L. Muetterties and W. D. Phillips. The authors describe how this technique has been used with advantage to determine not only the stereochemistry of the compounds in solution and solid state but also the reaction kinetics of fast reactions. A number of illustrative examples have been given to point out the sources of interpretational errors and methods of eliminating them.

These two books cover a wide range of subjects of current interest and their usefulness cannot be overemphasized.

H. B. MATHUR.

A. P. B. SINHA.

**Prestressed Concrete, Vols. I and II.** By Y. Guyon. (Asia Publishing House, Bombay), 1963. Pp. 559 and 741. Price Rs. 35.00 and 50.00 respectively.

The two books under review are the translations from the original French editions. The author is an international authority on prestressed concrete. The first volume contains all the basic information on prestressed concrete and the elastic design of simply-supported beams. In the second volume, the author has described in detail the elastic and ultimate-load design of statically indeterminate structures in prestressed concrete.

Volume I contains 18 chapters and 3 appendices. The first three chapters deal with basic phenomena of prestressed concrete, methods and plant and materials. Friction between cable and duct and fire resistance of prestressed concrete are treated in the 4th and 5th chapters. Chapters 6 to 8 contain an exhaustive treatment of anchorage zone stresses in post-tensioned and pre-tensioned beams. The elastic design of simply supported beams are discussed in detail in Chapters 9 to 13. Results of some tests on beams carried out in France have been described in Chapters 14 to 17. Chapter 18 contains some discussions on factors of safety and elastic-plastic design of beams.

Volume II deals with some statically

indeterminate prestressed concrete structural systems in 19 chapters and two appendices. Chapters 19 to 28 deal with the elastic analysis of indeterminate structures and contain material on general problems, concordant cable problems, continuous beams, arches and framed structures, joint and economy in design. The ultimate load analysis of indeterminate structures are dealt in Chapters 29 to 37. These chapters contain information on the ultimate moment of a section, discussion of results of tests conducted on various structures, slabs, moment-curvature relationship and ultimate load design.

An important aspect of these books is that much of the material contained in these is the author's own contribution. The two books together form an invaluable asset to designers and advanced students of prestressed concrete.

K. T. S. IYENGAR.

**The Genera of Fishes and a Classification of Fishes.** By David Starr Jordan. Reprinted with a new Foreword by George S. Myers and a Comprehensive Index by Hugh M. Smith and Leonard P. Schultz. (Stanford University Press, Stanford, California), 1963. Pp. xvi + 800. Price \$ 17.50.

This volume is a reprint of two widely followed reference books, '*The Genera of Fishes*' and '*A Classification of Fishes*' which were out of print for the last thirty years. *The Genera of Fishes* (1917-1920) was the first attempt to deal with all the genera of fishes known till then in accordance with the 'International Rules of Zoological Nomenclature'. Despite the subsequent addition of a large number of genera of fishes and a few imperfections, this book remains the prime reference for any work on the nomenclature of fishes. Though individual groups of fishes have been dealt with in detail by subsequent authors, no comprehensive work of this sort has been attempted. All the genera of fishes described by taxonomists from 1758 to 1920 are listed in the chronological order. Nearly 10,000 genera of fishes are included in this book and a current estimate is well over 15,000 genera. In the search for finding out the synonyms of the genera of fishes, this book is a dependable aid to the taxonomist. The 'Foreword' to the reprint by George S. Myers helps to understand the work in the perspective of subsequent changes.

Jordan describes his book '*A Classification of Fishes*' as a continuation and conclusion to the *Genera of Fishes*. All the genera of fishes

known till then are arranged in their respective places in the author's scheme of classification of fishes. Subsequent to Jordan's classification four more systems of classifications have been added, namely those of Regan (1929), Berg (1948), Grasse' (1955) and Romer (1959). Additions to the knowledge of the anatomy and evolution of fishes have necessitated many subsequent changes. Despite all these modifications, Jordan's scheme of classification is widely followed for arranging large collections of fishes in a suitable manner. An index which was originally compiled for this purpose by the Smithsonian Institution was suitably altered for the needs of this book by Hugh M. Smith and Leonard P. Schultz.

C. T. SAMUEL.

#### Pathology of Domestic Animals (Vols. 1 and 2).

By K. V. F. Jubb and P. C. Kennedy. (Academic Press, New York-3), 1963. Pp. xiii + 477; xv + 613. Price \$ 18.00; \$ 24.00.

The two volumes of the book contain detailed and comprehensive information on the pathology of domestic animals, though the subject-matter has been arranged in a way different from the conventional procedure followed by authors of text-books in Pathology. General Pathology has not been dealt with in detail as the same is to be found in almost all the existing text-books of pathology. However, general pathology has been discussed in relation to special or systemic pathology. Comprehensive information has been given on special and specific disease pathology and the entire subject-matter has been so conveniently arranged that the reader will get all the required information on a particular specific disease in one place under the organ system. This is very helpful to the student of pathology in understanding not only the already known diseases of domestic animals but also some new diseases of obscure nature.

A broad search for a thorough understanding of several endemic and epidemic diseases in veterinary science has not been made as the veterinary scientist is always engaged in quickly finding ways and means of tackling the immediate problem of prevention and control of the disease. The ultimate object of all study of diseases is to provide a fair knowledge of the disease which will help in preventing it immediately. The authors have kept this point in view and have succeeded considerably in achieving this aim. In my opinion it is a valuable contribution on Animal Pathology, and

should prove useful as a guide and reference for students of research in diseases of domestic animals, particularly in the field of bacteriology, virology, parasitology, and oncology.

The authors have taken great pains to illustrate most of the pathological lesions described in this book with very good photographs and photomicrographs which will help the reader in a quick understanding of the subject.

SYED MOHTYUDDIN.

#### Books Received

*Economic Mineral Deposits of India.* By S. K. Borooah. (Sewali Prakash Bhawan, Nowgong, Assam), 1964. Pp. ix + 202. Price Rs. 10.

*Fish Catching Methods of the World.* By A. W. Brandt. (Fishing News Ltd., Luggate House, 110, Fleet Street, London E.C. 4), 1964. Pp. xxiv + 191. Price \$ 8.50.

*The Development of Weak Interaction Theory.* Edited by P. K. Kabir. (Gordon and Breach, 150 Fifth Avenue, New York-11), 1964. Pp. xxv + 286. Price \$ 4.95.

*Nuclear Orientation.* Edited by M. E. Rose. (Gordon and Breach, New York-11), 1964. Pp. xiv + 321. Price \$ 4.95.

*Mechanical and Electrical Vibrations.* By J. R. Barker. (Methuen and Co., London, E.C. 4), 1964. Pp. vi + 221. Price 21 sh.

*A Course of Mathematics for Engineers and Scientists (Vol. 4).* Edited by C. Plumpton and B. H. Chirgwin. (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. viii + 353. Price 35 sh.

*The Periodic Table.* By D. G. Cooper. (Butterworth and Co., London, W.C. 2), 1964. Pp. x + 110. Price 10/6 d.

*The Nuclear Reactor.* By A. Salmon. (Methuen and Co., London, E.C. 4), 1964. Pp. 144. Price 16 sh.

*Elements of Modern Pure Geometry.* By M. S. R. Anjaneyulu. (Asia Publishing House, Bombay-1), 1964. Pp. x + 167. Price Rs. 10.

*Somapsyche—An Integrated Biological Approach Towards the Understanding of Man's Body and Mind.* (The University of Patna, Patna, Bihar), 1962. Pp. 133. Price Rs. 12.

*The Role of Science in the Development of Natural Resources with Particular Reference to Pakistan, Iran and Turkey.* (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. xix + 454. Price 50 sh.

*High Energy Interactions—International Conference on Cosmic Rays Proceedings (Vol. 5).* (Tata Institute of Fundamental Research, Colaba, Bombay-5), Pp. 595. Price Rs. 30.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

The M.S. University of Baroda has awarded the Ph.D. degree in Physics to Shri A. P. Balasubramanian for his thesis entitled "Optical Studies on Metal Crystals—(Zinc and Antimony)".

Osmania University has awarded the Ph.D. degree in Mathematics to Shri U. Agastaya Sastry for his thesis entitled "Problems on Torsion and Flexure of Prismatic Bars, Thermal Stresses and Forced Laminar Convection in Tubes".

### Science Progress

As mentioned by us when we reviewed the January 1964 issue (see *Curr. Sci.*, May 5) this popular quarterly scientific journal has commenced appearing in an improved format and print, with article contents, written by specialists in the field, on border subjects of common interest to workers in different disciplines. The July 1964 issue contains the following review articles: Haemoglobin by E. R. Huehns; Photosynthesis by C. P. Whittingham; Some new ways of looking at cosmic rays by G. W. Hutchinson; Energy flow and population metabolism ancient and modern by Clifford J. Hart. lism by F. B. O'Connor and Photophones—

The topics selected for Recent Advances are: (Astronomy) Quasi-stellar radio sources, (Organic Chemistry) Penicillin Chemistry, (Geology) Stratigraphical Classification, (Zoology) The ancestry of the tetrapods, and (Botany) Aspects of the chemistry and inheritance of mitochondria.

### Occurrence of *Pestalotiopsis glandicola* (Cast.) Steyaert in India

Shri S. N. Bhargava, Botany Department, University of Allahabad, Allahabad, writes as follows:

Recently, in a note published in *Current Science* (1964, 33, 411) Rama Rao has claimed that this was the first record of *Pestalotiopsis glandicola* from India.

The occurrence of *P. glandicola* in India was recorded for the first time by Tandon and Bhargava [Physiological studies of *P. glandicola* (Cast) Steyaert, *Bull. Bot. Soc.*, University of Saugar, 1961, 13, 13-21] who isolated this fungus from diseased leaves of *Thea sinensis* L. Later on Agarwal [Fungi Causing Plant Diseases at Jabalpur (M.P.), *Proc. 49th Ind. Sci. Cong.*,

Part III, Abstracts, 1962, 240] also reported *P. glandicola* causing leaf spot disease of *Gassia tora* L. at Jabalpur (M.P.).

### Sugars and Amino-Acids in the Die-Back Affected Nagpur Oranges (*Citrus reticulata* Blanco).

D. Suryanarayana, R. Upadhyay and B. L. Chona, Division of Mycology and Plant Pathology, I.A.R.I., New Delhi, write:

Recently the authors made a comparative study of carbohydrate and amino-acid status in the die-back-affected and healthy twigs of Nagpur santra (*Citrus reticulata* Blanco) by ascending paper chromatographic technique.

Comparison was made for 10 amino-acids, viz., Aspartic acid, Alanine, Glutamic acid, Valine, Proline, Tyrosine, Phenylalanine, Norvaline, Leucine and an unknown amino-acid. It was found that in the diseased material Aspartic acid, Alanine, Glutamic acid are in lesser quantity whereas Phenylalanine is totally absent. Comparison was also made for three sugars met with in the experimental material, i.e., Sucrose, Galactose and Fructose and no difference in the diseased and healthy material could be found so far as the sugars are concerned.

### Synthesis of Fluorinated Boron Hydride

National Bureau of Standards, U.S., has announced the successful synthesis of difluoroborane ( $\text{HBF}_2$ ). Difluoroborane was discovered during investigations of boron derivatives. The chemistry of boron hydrides has been a subject of interest in recent times firstly because of their usefulness as reducing agents, and secondly because of their potential use as chemical fuels or fuel additives.

There are two distinct methods for synthesizing difluoroborane. The most direct approach is pyrolysis of diborane at  $100^\circ\text{C}$ ., in the presence of boron trifluoride. Much diborane is destroyed in this process, but some interchange of fluorine and hydrogen atoms also occurs, leading to the formation of  $\text{HBF}_2$ . The other, more useful synthetic procedure, is the reaction of boron trifluoride with dimethoxyborane,  $\text{HB}(\text{OCH}_3)_2$ . The reaction is rapid, even at  $0^\circ$ . Studies of this system using isotopically labelled starting materials reveal that the reaction is complex, involving rapid exchanges of all groups bonded to boron atoms.

Difluoroborane, a gas at room temperature, boils at about  $-100^{\circ}\text{C}$ . Because it is sensitive to traces of air and moisture, high-vacuum techniques are required for its preparation and study. The compound was characterized as monomeric  $\text{HBF}_2$  on the basis of molecular weight, infrared data, and chemical reactions. The structure has been confirmed by low-temperature high-resolution nuclear magnetic resonance studies. Its chemical properties include reactions with Lewis bases such as amines and ethers. Addition of the B-H linkage across olefinic double bonds results in formation of saturated organoboron difluorides.—(*Jour. Frank. Inst.*, 1964, 277, 509.)

### Progress in DNA Synthesis

Deoxyribonucleic acid (DNA) is the molecule that carries genetic information of living organisms. As found in the living cell, the DNA molecule contains thousands or tens of thousands of the four different subunits called bases: adenine (A), thymine (T), guanine (G), and cytosine (C). The sequence of these bases provides the genetic code the cell uses in manufacturing proteins.

At the University of Wisconsin H. G. Khorana and his colleagues have been working at the problem of synthesis of DNA chains for the last ten years. Their progress to date was reported recently at the April meeting of the Federation of American Societies for Experimental Biology. In one method short DNA chains are built up directly coupling one base to another. The bases are actually in the form of nucleotides, structures in which a base has been linked to a sugar molecule and a phosphate group. Using this stepwise method they have synthesized DNA molecules 9 to 12 bases long. The practical limit for this method appears to be 20 bases. In an alternative method performed base doublets (for example TC, TG and AC) have been coupled into sequences containing six doublets. The extension by this method to triplets is under study.

To create still longer DNA molecules of known sequence it has been found necessary to use a biological catalyst, namely, the enzyme DNA polymerase. With its help a synthetic chain containing six doublets was used to make a chain of doublets thousands of pairs long. In this case the original doublet was AT whereas the much longer molecule contained strings of

the complementary doublet TA. Efforts to use these synthetic DNA chains in biologically active systems to produce synthetic proteins are still in an early stage but appear promising.—(*Sci. Amer.*, June 1964.)

### Characteristics of Neutron Stars as Sources of Celestial X-Rays

The recent discovery of galactic X-rays, which was quite unexpected from our present understanding of physical processes in astronomical objects, has induced a variety of theoretical investigations. Among various mechanisms so far proposed to explain the X-ray sources, the neutron-star hypothesis suggested by several authors seems to present a reasonable combination of the radiative power, the distance, the life and the frequency of occurrence of the X-ray sources although the existence of neutron stars is still open to question.

A neutron star is expected to appear after a supernova explosion occurs. Typical characteristics may be described as follows: The radius is about 10 km.; the mass is about one solar mass, the density being about  $10^{15}\text{ g./c.c.}$ ; the surface temperature may be originally  $10^7^{\circ}\text{K}$ . and cools down with a half-life of about a thousand years. This star, which radiates mostly in the X-ray region, can be a strong source of X-rays, if it is at a distance, of the order of a thousand light-years. This distance, considering that the life of the neutron star is about a thousand years, is compatible with occurrence frequency of super-novæ in the galaxy. Indeed, an X-ray source was reported by Friedman the direction of which agrees well with the Crab Nebula, which is a remnant of the supernova of A.D. 1054.—(*Nature*, 1964, 202, 1321.)

### The Exhibition of Instruments

The All-India Instrument Manufacturers and Dealers Association through its Bombay Regional Centre has organised an Exhibition of Instruments in the Jehangir Art Gallery, Bombay-1, from the 3rd to 6th September 1964. Nearly 30 leading scientific instrument manufacturers and dealers in the country would be participating in this exhibition.

The Exhibitors would be displaying a wide variety of instruments from simple laboratory equipment to sophisticated electronic instruments. A section of the exhibition place is reserved for Ancillary Industries wherein Components and Accessories and allied requirements of the Instrument Industry would be displayed.

## PHYSIOLOGY OF MOLLUSCA

**M**ALACOLOGISTS the world over will warmly welcome the enterprise of the Academic Press in undertaking the publication of a treatise in two volumes dealing with the physiology of mollusca on a comprehensive basis. Volume I was published in April of this year\* and Volume II will appear in due course. The aim of the work is to present a full and critical survey of the voluminous literature of the subject, but in an attractive fashion. Physiology has been interpreted very broadly in the planning of the volumes. In addition to the subdivisions usually found in physiological literature, chapters are included dealing with the physiological aspects of development (although not with classic embryology), also with ecology in the sea, in freshwaters, and on land, and with behaviour and learning in those most highly evolved molluscs, the Cephalopoda.

The Mollusca constitute a phylum of unusual interest. Built on a relatively simple ground plan, they display a range of adaptive radiation unparalleled outside the Arthropoda and the Chordata. The success of the Mollusca has been due to the efficiency of their various, and often characteristic, organ systems and it is with this success that these volumes are primarily concerned. So great are the structural and functional divergences within the phylum that workers on the Gastropoda, on the Bivalvia, and on the smaller molluscan classes may not be conversant with the investigations of those who study the more highly organized Cephalopoda, and the converse may also be true. In the present volume all groups of malacologists would find common meeting grounds.

Physiology must be firmly based on structure and systematics. As a consequence, the first chapter of the book is devoted to the classification and structure of the mollusca. The subsequent chapters of the volume have the following titles: Physiological Aspects of the Ecology of Intertidal Molluscs; Physiological Aspects of Ecology in Nonmarine Molluscs; Reproduction; Development; The Culture of Marine Bivalve Larvæ; Growth; Shell Formation and Regeneration; Osmotic and Ionic Regulation; Muscle and

Neuromuscular Physiology; Special Effectors; Luminous Organs, Chromatophores, Pigments, and Poison Glands; Locomotion; The Buoyance of Marine Molluscs. For Volume II, we are promised chapters on the following topics: Feeding; Digestion; Feeding and Digestion in Cephalopods; Pigmentation of Molluscs; Respiration; Metabolism: Carbohydrates and Lipids; Metabolism: Nitrogen Compounds; Heat, Circulation, and Blood Cells; Excretion; Physiology of the Nervous System; Sense-Organs (less Cephalopods); Sense-Organs of Cephalopods.

The extensive scientific coverage and the vast variety of molluscan forms would together have resulted in a volume of immense size, had not the editors wisely restricted themselves in an appropriate fashion. They decided to lay aside the historical approach and to emphasize instead the developments and experimentations of recent years. This has resulted in increasing the interest of the volume to those actively working in the field and also made it more attractive to the general reader.

The nature and scope of the work made it inevitable that its production needed the co-operation of numerous specialists for presenting an authoritative account of the state of knowledge in their respective fields. The list of contributors to the first volume includes twelve specialists besides the two editors. It is noteworthy that ten out of these fourteen contributors hail from Great Britain, two others being from the United States, one from New Zealand and one from the Netherlands. The need for the co-operation of specialists is obvious on a glance at the extensive list of references to be found at the end of each chapter. All that literature needed to be assimilated and its outcome presented in an intelligible and attractive form for the benefit of the reader.

It would be appropriate here to mention the importance which a study of the mollusca possesses considered even from the standpoint of practical economics. The subject of pearl oysters and arising out of it the development of the so-called culture-pearl industry in Japan and elsewhere naturally comes to mind. Numerous marine bivalves as for example, *Ostrea edulis*, possess a food value and hence have been cultured upwards from the larval stage. The Octopus is well known as a

\* *Physiology of Mollusca*, Volume I, Edited by Karl M. Wilbur and C. M. Yonge (Academic Press, Inc., 111, Fifth Avenue, New York 3), 1964. Pp. xiii + 473. Price \$ 16.00.

marine food-product. The shells of mollusca are much sought after by reason of their beauty of form or colour or on account of the attractive properties of the material of which they consist. Even when lacking in such properties, they are useful when burnt as a source of pure lime.

Apart, however, from all considerations of economics, the mollusca are of fundamental importance in biological studies. They represent one of the oldest forms of life on the earth. The number of varieties of land, freshwater, and marine molluscs is almost incredibly large. Indeed more than a hundred thousand species are known to science. They range in size from microscopic specimens up to huge clams weighing half a ton and big enough to be used as a bath-tub. The variety of form and colour offered by molluscan shells is unsurpassed by any branch of biological life, so much so that the study of the subject becomes an adventure in itself. The molluscs inhabit not only the oceanic waters, but also live in lakes, rivers and

ponds, where there are thousands of specimens only less interesting than the marine species. There are also air-breathing shells of many kinds which live on the land, in trees and bushes, on the ground in your garden, in short under a wide range of conditions. A brief survey of the varieties found in any locality, whether on the seashore or on land, will open the eyes with wonder at the extent of this form of life. The interested observer, wherever he may dwell, will find in his neighbourhood a sufficient variety of forms of shell life to make their study a source of real enjoyment.

It follows from all that has been stated that the studies of molluscan physiology embodied in the volume under review would be of interest to a wide circle of readers. The attractiveness of the volume is enhanced by choice illustrations which find a place in its pages and by the technical excellence of the printing. Its readers will look forward eagerly to the appearance of the second volume.

C. V. R.

## THE REDDENING CAUSED BY DUST GRAINS IN A STELLAR CLUSTER

I. P. WILLIAMS

*Mathematics Department, Reading University*

### 1. INTRODUCTION

**I**F a solid body intersects a ray of light, in general, this ray will either be absorbed or scattered. However, if the wavelength of the light concerned is comparable to the diameter of the body, some light can continue past the body. As a result interstellar dust grains absorb more light from the blue end of the spectrum than from the red. This effect is usually called interstellar reddening.

By using three-colour photometry (the UBV system) it is possible to estimate the amount of reddening due to material between a stellar cluster and the observer, this being the same for all the stars in the cluster. If, however, there is also some reddening due to dust grains in the cluster itself, this will vary from star to star, resulting in irregular reddening. Two problems of interest in this context are:

(1) Many observational astronomers have observed stellar clusters in which the reddening appears to vary irregularly from star to star. Is it possible to produce very irregular reddening in a stellar cluster without requiring a phenomenally large mass of interstellar material?

(2) It is generally believed that most stellar clusters contain a few solar masses of material in the form of dust grains and gas clouds. On the other hand, very irregular reddening is not a common occurrence. Can the above amount of material be present in a cluster in such a form as not to produce irregular reddening of necessity?

In § 2 we define a convenient parameter for measuring the reddening produced. This is used in § 3 to determine whether irregular reddening can be produced using a reasonable amount of material, while in § 4 we show that several solar masses of interstellar material can be present without of necessity producing irregular reddening. In § 5 we give an example of the reddening effects produced by a cloud system, without suggesting that this relates to any particular cluster.

### 2. THE REDDENING COEFFICIENT

Reddening is caused by the intersection of a light ray by an interstellar grain. A convenient measure for the reddening is thus the average number of such grains per light ray. The number along a length  $l$  of a ray is the number

of grains whose centres be inside a cylinder of radius  $\sigma$  (the grain radius) and length  $l$ , or  $\pi\sigma^2nl$  where  $n$  is the mean number density of the grains. Denote this number by  $A$ , and for convenience call it the reddening coefficient, so we have

$$A = \pi\sigma^2nl. \quad (1)$$

Values of  $A$  near unity will denote appreciable reddening while  $A$  close to zero denotes little reddening.

### 3. THE MASS REQUIRED FOR APPRECIABLE REDDENING

In the first problem mentioned we require to show that irregular reddening can be caused by interstellar grains in reasonable numbers. Consider a uniform distribution of grains in the cluster, then the reddening coefficient for any star is given by  $A = \pi\sigma^2ln$ ,  $l$  being the depth to which the star is immersed in the cluster. Thus provided  $A$  becomes near unity for the maximum value of  $l$ , namely,  $2R_c$  where  $R_c$  is the cluster radius, a great variation in the reddening can occur as  $l$  varies from 0 to  $2R_c$ . We thus require

$$1 = 2\pi\sigma^2R_cn$$

$$n = \frac{1}{2\pi\sigma^2R_c}. \quad (2)$$

When  $n$  satisfies the above irregular reddening is caused. We now have to deduce what mass the required value of  $n$  implies.

The total mass of grains in the cluster is

$$\frac{4}{3}\pi R_c^3 mn = \frac{2}{3} \frac{R_c^2 m}{\sigma^2},$$

$m$  being the average mass of a grain. If the grains form a proportion  $\mu$  by weight of the interstellar material, then the total mass present is

$$\frac{2R_c^2 m}{3\mu\sigma^2}, \quad (3)$$

at a density of

$$\frac{m}{2\pi R_c \sigma^2 \mu}. \quad (4)$$

Let us now introduce numerical values. Allen<sup>1</sup> gives the following:

Mass of grain =  $m = 10^{-13}$  gm.

Radius of grain =  $\sigma = 3 \times 10^{-5}$  cm.

Proportion of grain to dust =  $\mu = 10^{-2}$ .

Average cluster radius =  $R \sim 1$  parsec.

Substitution into equations (3) and (4) gives a mass of  $6.7 \times 10^{34}$  gm. at a mean density of

$6 \times 10^{22}$  gm./c.c. These are both values that can exist in a cluster and we have thus shown that it is possible to produce irregular reddening without requiring an unreasonably large amount of material.

### 4. MASS ALLOWED BEFORE CAUSING APPRECIABLE REDDENING

Clearly if the grains were to be distributed as in § 3 the reddening would not be appreciable only if  $A$  were to become small throughout, thus requiring a reduction by a factor  $10^2$  at least in  $n$  and hence in the mass, giving us  $6.7 \times 10^{32}$  gm. While this is a considerable amount it is not of the order of several solar masses mentioned earlier. We can thus only have the additional mass required in regions of higher density, regions that do not on average cause any reddening. Clearly this can only be so if the regions are so small as to make the probability of them obscuring a star very small. For mathematical simplicity we shall assume that all the regions have the same radius  $R$  and density  $\rho$ , there being  $N$  of them. Let there be  $B$  stars distributed uniformly through the cluster.

If a ray of light has length  $s$ , then there will on average be  $(3N/4\pi R^3) \cdot \pi R^2 s$  intersections by these high density regions. Take the centre of the cluster as origin of a rectangular set of axes, with the  $x$ -axis towards the observer. All parts of a ring with radius between  $y$  and  $y + dy$  with thickness  $dx$  will have  $s = \sqrt{R_c^2 - y^2 - x^2}$  and will contain  $(3B/4\pi R_c^3) \cdot 2\pi y dy dx$  stars (or sources of light rays).

The number of light rays intersected will thus be

$$\frac{3B}{2R_c^3} \cdot y dy dx \frac{3N}{4R_c^3} R^2 \{ \sqrt{R_c^2 - y^2 - x^2} \},$$

and so the total number of stars reddened will be on average

$$\frac{9NR^2B}{8R_c^3} \int_0^{R_c} y dy \int_{-R_c}^{R_c} \{ \sqrt{R_c^2 - y^2 - x^2} \} dx$$

$$= \frac{3NBR^2}{4R_c^2}. \quad (5)$$

If no stars are to be reddened, then on average this number must be less than unity, or

$$3NBR^2 < 4R_c^2.$$

An average stellar cluster contains about 300 stars, thus we require

$$NR^2 < 4 \times 10^{34}. \quad (6)$$

The total mass in grain and gas form is

$$\frac{4}{3} \pi R^3 \rho N,$$

and combining this with (6) gives us a maximum value for the mass when  $N = 1$  and  $R = 2 \times 10^{17}$  cm., thus giving a mass of  $3.35 \times 10^{52}$  gm. Hence if the density of the region is about  $3 \times 10^{-19}$  gm./c.c. then several solar masses of material can be present in dust and gas form. The value for the density is reasonable and thus we conclude that the required mass can be present without causing appreciable reddening.

#### 5. REDDENING CAUSED BY A SYSTEM OF CLOUDS

In the above paragraphs we have considered very simple mathematical models, using only clouds with one given radius. In this section we shall consider a system of clouds, again with a constant density, but with the cloud radii varying such that the number of clouds  $N(r)$  with radii between  $r$  and  $r + dr$  is given by

$$N(r) = \frac{N}{R} \exp \left\{ \frac{-r}{R} \right\},$$

The reddening produced by the above distribution would be irregular as it depends on the cloud radii and these vary through the cluster. Given physical values for the parameters we can calculate the number of stars reddened to any given degree. It is of more interest to find the total number of stars reddened to some extent. This in view of (5) would be

$$\int_0^\infty \frac{3N(r) Br^2 dr}{4R_c^2} = \frac{3NBR^2}{4R_c^2}. \quad (8)$$

$M$  is several solar masses and for definiteness we shall take it to be  $10^{34}$  gm. (5 solar masses). Using equations (7) and (8) we have calculated the total number of stars reddened,  $T$ , and the number of clouds in the system,  $N$ , assuming various densities and mean radii. The results are given in Table I. Clearly if  $T > 300$  or  $N < 1$  then the values have no meaning and tabulation has thus ceased.

TABLE I

$\rho = 10^{-20}$ gm./c.c.	R (cm.)	$10^{16}$	$2 \times 10^{16}$	$4 \times 10^{16}$	$6 \times 10^{16}$	$8 \times 10^{16}$	$10^{17}$	$2 \times 10^{17}$
	N	$4 \times 10^4$	$5 \times 10^3$	625	180	78	40	5
	T	200	100	50	33	25	20	10
$\rho = 5 \times 10^{-21}$ gm./c.c.	R (cm.)	$2 \times 10^{16}$	$4 \times 10^{16}$	$6 \times 10^{16}$	$8 \times 10^{16}$	$10^{17}$	$2 \times 10^{17}$	$4 \times 10^{17}$
	N	$10^4$	$1.25 \times 10^3$	560	156	80	10	1.25
	T	200	100	66	50	40	20	10
$\rho = 10^{-21}$ gm./c.c.	R (cm.)	$4 \times 10^{16}$	$6 \times 10^{16}$	$8 \times 10^{16}$	$10^{17}$	$2 \times 10^{17}$	$4 \times 10^{17}$	$6 \times 10^{17}$
	N	$6.25 \times 10^3$	$1.8 \times 10^3$	780	400	50	6.25	1.8
	T	500	333	250	200	100	50	32

$N$  being the total number of clouds and  $R$  their mean radius, thus

$$N = \int_0^\infty N(r) dr$$

and

$$N.R = \int_0^\infty rN(r) dr.$$

If the total mass of interstellar material present is  $M$  then we have

$$M = \int_0^\infty \frac{4}{3} \pi \rho r^3 N(r) dr = 8\pi \rho N R^3. \quad (7)$$

Table I shows that on using reasonable values for  $\rho$  and  $R$  an appreciable number of stars can be reddened to some extent.

#### 6. CONCLUSIONS

By means of simple mathematical models we have shown that it is possible to produce very irregular reddening without requiring an excessive amount of interstellar material. It has also been shown that several solar masses of interstellar material in a cluster need not imply irregular reddening.

Finally, an example has been given using a slightly more complex system of interstellar clouds, and the number of stars reddened has been calculated.



## ON THE OCCURRENCE OF *ORYZA* SPECIES IN SOUTH-WESTERN INDIA AND ITS SIGNIFICANCE

N. R. NAIR, N. M. NAYAR AND P. C. SAHADEVAN\*

Department of Agriculture, Kerala State

**I**N his classification of the genus *Oryza*, Chatterjee<sup>1</sup> recognized 23 species including the 2 cultivated species, *O. sativa* and *O. glaberrima*. Later, 4 more species have been described.<sup>2-5</sup>

Chatterjee (loc. cit.) had recorded 5 species as occurring in India. They are *O. sativa*, *O. sativa* var. *fatua*, *O. officinalis*, *O. coarctata* and *O. granulata*. Since then, Ramiah and Ghose,<sup>6</sup> and Sampath and Rao<sup>7</sup> recognized the perennial, floating wild rices occurring in Orissa as a form of *O. perennis*. Of the 4 species enumerated subsequent to Chatterjee's classification, 2 were from India. They are *O. malampuzhensis* and *O. jeyporensis*. Very little is, however, known about the latter species. Thus, out of 27 species in the genus *Oryza*, as many as 7 have been recorded to occur in India. However, the range of distribution in India of each has not been determined so far.

In South-Western India, in the area primarily covered by Kerala State, the occurrence of 4 species has been recorded so far. They are *O. granulata*,<sup>8</sup> *O. coarctata*,<sup>9</sup> *O. malampuzhensis*,<sup>1</sup> and the cultivated species, *O. sativa*. The National Herbarium, Sibpore, has specimens of *O. officinalis* collected from South Canara and Courtallam.<sup>10</sup> Wild rices known as 'vari' occur extensively in this region, most commonly as a noxious weed in paddy lands. They have generally been considered as *O. sativa* var. *fatua*. But recent studies made by the authors have shown that they are a highly heterogeneous complex group and are similar to the wild rices of Orissa and neighbouring areas studied at the Central Rice Research Institute, Cuttack.<sup>11-12</sup>

This group was found to include a perennial, floating type of wild rice described below, that corresponds to the form variously named as *O. perennis* var. *balunga*<sup>11-12</sup> and as *O. balunga*<sup>13</sup> (*O. perennis* subsp. *balunga* as adopted by the recent Symposium on Rice Genetics and Cytogenetics).<sup>14</sup> This is the first record of its occurrence from this region.

This species, *O. perennis* subsp. *balunga*, occurs mainly in ponds, disused channels, wayside ditches, marshy lands, etc., and is perennial in habit. It does not usually occur

as weeds in paddy lands. Depending on the habitat and ecological conditions it may assume various forms. Under typically aquatic conditions, it develops a floating habit with long, many-branched stems having roots and axillary branches, at the nodes (Fig. 1) and under



FIG. 1. A young plant of *O. perennis* subsp. *balunga*. Note the long branched stems with roots and branches from the nodes.

mesophytic conditions it develops an open, prostrate, or often, rosette habit. It propagates equally well by seeds and by bits of stems of older plants. The leaves are long and narrow, the auricle curved and hairy, and the ligule elongated, acute and split. The panicle is open with 4 to 8 branches and has 25 to 75 spikelets (Fig. 2). The spikelet is narrow, 6 to 8 mm. long with slender awns 20 to 65 mm. long. The spikelets are easily shed at maturity. The anthers are deep yellow when ripe and characteristically fill more than two-thirds of the glumes. The plants flower almost throughout the year with most of the flowering occurring between September and November. The mature spikelet is black or smoky in colour and the pericarp a dull red. A number of plant parts may show anthocyanin pigmentation, but its intensity and distribution vary widely. In a majority of plants, pigmentation is seen in leaf-sheath, leaf axil, leaf tip and margin, internode, stigma and awns. Very occasionally plants with fully pigmented leaves are also noticed, but sometimes this colour turns to green on maturity. Pigmentation is also sometimes noticed in other plant parts as ligule, junctura, septum, glumes and lemma-palea. A herbarium sheet of the species from a specimen collected in February, has been deposited in the Central National Herbarium, Sibpore (No. 20,034)

\* Presently, Assistant Rice Research Officer, Rice Research Station, Moncompu, Kerala State; Cytogeneticist, Central Potato Research Institute, Simla; and Joint Director of Agriculture, Trivandrum, respectively.

This South Indian form of *O. perennis* is generally similar morphologically to those occurring in Orissa and other parts of Eastern India, as seen from the description.<sup>11-12</sup> However, the ability of the former to produce flowers almost throughout the year is worthy of notice. It

considered to be the result of introgressive hybridization between the cultivated species *O. sativa* and the wild species *O. perennis*, as has been established in the case of wild rice occurring in Orissa.<sup>11-12</sup> They correspond to *O. sativa* var. *fatua*, following Chatterjee's classification<sup>1</sup> (*O. rufipogon* Griffith of Sampath<sup>15</sup>).



FIG. 2. A panicle of *O. perennis* subsp. *balunga*.

signifies that it differs from the East Indian form in its photoperiod sensitivity. The peak flowering period of the latter is October to December and stray flowers may be observed until March.<sup>11</sup> This characteristic of the South Indian form is evidently an evolutionary adaptation brought about by the near-tropical conditions prevailing in its area of distribution and the consequent absence of any appreciable difference in daylengths from month to month in this region. Sampath<sup>15</sup> has recently pointed out that the species *O. perennis* may have differentiated into subspecies in different regions.

In addition to the type of *O. perennis* described above, the wild rices of this region were also found to include a highly complex and variable group of plants (Fig. 3). They are always annuals and occur typically as weeds in paddy fields, always sympatrically with the cultivated species, *O. sativa*. They show considerable variation in all their morphological characters, and are mostly heterozygous, exhibiting varying amounts of semisterility. Heterozygosity and semisterility are characteristics of a hybrid origin. These "Spontanea" forms of wild rices<sup>7-11</sup> can also be



FIG. 3. *O. sativa* var. *fatua* (*O. rufipogon*).

This wild rice is the most noxious of all rice weeds in this region, particularly in the *viripunt* or *kanni* crop (April to August). They are hardly distinguished from the rice crop until after they are in flower and at that stage they are very difficult to be removed from the fields. The spread and diversification of this rice weed can be attributed to natural crossing between *O. rufipogon* and cultivated rice. The entire complex of wild rice populations presents a continuous range of variability but, as pointed out by Sampath,<sup>15</sup> typical forms of the two species, *O. perennis*, and *O. rufipogon*, can be differentiated by selecting the extreme classes or by taking into account a group of characters.

In this region, it is possible to see, throughout the year, rice in various stages of culture grown under extremely varied conditions. It is also cultivated in areas which are 2 to 3 meters below mean sea-level and as well as in areas

which are over 1,100 meters above M.S.L. The soil in which the crop is grown may be sandy, lateritic, loamy, heavy clayey or peaty. The periods of maturity of the varieties range from 60 days to over 200 days. There are varieties which are adapted to typical upland conditions: to flooded or deep water conditions or to heavy acid soils. A few varieties are typically shade-loving. Two distinct characteristics of all the indigenous varieties are the coarse or bold grain and the red pericarp colour. These characteristics are well established and the people of this region show a definite preference for varieties with bold grain and red pericarp. This preference is not found in other areas.

The above observations on the occurrence and characteristics of the wild and cultivated rices may provide some support to the theory that the peninsular India, and more particularly the area to the west of the Western Ghats, may well be the centre of origin of the genus *Oryza* and probably one of the centres of origin of *O. sativa*. The latter theory was first proposed by DeCandolle in his classic 'The Origin of Cultivated Plants' and this was later supported by Watt<sup>16</sup> and Ramiah and Ghose.<sup>6</sup> Watt based his suggestion chiefly on philological evidences. Ramiah and Ghose supported it by pointing out the references on rice in some of the ancient Dravidian literature.

This theory can be supported on the basis of the 'differential phytogeographical method' for determining the centre of origin as proposed by Vavilov,<sup>17</sup> Cain,<sup>18</sup> and Polunin.<sup>19</sup> It has been pointed out earlier that within a comparatively restricted region, hemmed in between the Western Ghats and the Arabian Sea, the occurrence of as many as 5 wild species, out of the total of 25 wild species of the genus, had been recorded. Both the cultivated species *O. sativa* and its putative ancestor *O. perennis* (subsp. *balunga*)<sup>6,7</sup> manifest themselves in considerable diversity in this region. Much of the area is mountainous and can be considered to have been inaccessible and isolated in ancient times. Presence of some endemic and genetically dominant characters can also be pointed out. The best examples are the red pericarp colour and the bold grain, both of which are characteristic of all the indigenous varieties of the region. The same can also be said, but with less emphasis, about some of the other characters, such as presence of awn, and anthocyanin pigmentation, ripening black lemma-palea colour and some of the physiological features pointed

out earlier. These are present in many of the local varieties.

It is not, of course, possible to draw definite conclusions with the available evidences. More extensive genetical data and sufficient archaeological evidence will be required for this. The present observations, however, point out to the need for a detailed survey of the region for the collection and genetic evaluation of all the local varieties and types, similar to the one conducted in the Jeypore tract of Orissa, which has been suggested as a secondary centre of origin of rice.<sup>6</sup> Unlike in Jeypore where there has been no man's interference and replacement with selected strains, rice has been subjected to much of human selection in the natural material in this region. Therefore a survey may throw more light on the question of evolution of varieties and it will also help in conserving the rich germplasm resources of the region, which is now being gradually depleted consequent on the steady replacement of existing local varieties with improved strains.

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# IAA- AND COUMARIN-DEPENDENT REVERSION OF THE CCC-INDUCED RETARDATION OF GROWTH

J. S. KNYPL

Department of Plant Physiology, University of Lodz, (Lodz, ul. Narutowicza 68), Poland

**2-CHLOROETHYL** trimethylammonium chloride (CCC) affects seed germination,<sup>1</sup> flowering<sup>2</sup> and growth<sup>3</sup> of intact plants in a manner opposite to that of gibberellin. Generally speaking, CCC produces plants with markedly shortened internodes and petioles; total leaf area of the treated plant may be increased.<sup>4</sup> Gibberellic acid (GA) prevents or markedly reduces morphological<sup>3</sup> and cytological<sup>5</sup> symptoms of the retardant action. This compound inhibits also synthesis of GA in *Fusarium moniliforme*.<sup>6</sup> However, on a basis of results of experiments carried out on plant sections it has recently been proposed that the "anti-gibberellinic" activity of CCC is due to lowering of a diffusible auxin level in the plant.<sup>7</sup> In accordance with this suggestion is a finding<sup>8</sup> that growth-retarding chemicals interact with GA in the IAA-oxidase system of cucumber. In contrast with this suggestion is a finding that neither GA nor auxin were potent to reverse the retardant-induced inhibition of growth of the *in vitro* cultivated plant tissues.<sup>9</sup> Moreover, GA in some instances enhanced the CCC-dependent inhibitions.<sup>7,9</sup>

CCC stimulated both growth of *Lens culinaris* root sections<sup>10</sup> and rooting of *Convolvulus sepium* segments.<sup>11</sup> The latter finding has been interpreted as pointing out the anti-gibberellinic character of the retardant. It will be seen from the data reported below that CCC did not affect the GA-stimulated growth of the first leaf of maize seedling sections, but it markedly affected the auxin-dependent growth phenomena.

Experiments were carried out on 7-9 cm. long etiolated sunflower (*Helianthus annuus* L., var. Pastewny) seedlings, according to a technique described previously.<sup>12</sup> 10 mm. hypocotyl sections, dissected out of a zone of maximal elongation, i.e., about 5 mm. below the cotyledonary node, were floated on distilled water for 2 hours, then washed with tap-water, blotted on a filter-paper, divided into lots of 6, rapidly weighed on a torsion balance and transferred into Petri-dishes (5.5 cm.) containing 10 ml. of solutions intended for the examination. The dishes were incubated under a mixed incandescent and fluorescent light<sup>12</sup> at 26-27° C. After a suitable period of time the sections were weighed again: Increment of fresh weight

was taken as the measure of growth. Each type of test was repeated in 4 series; each series contained 2-3 replicas. The results, according to F-tests, are significant at  $P = 0.05$ .

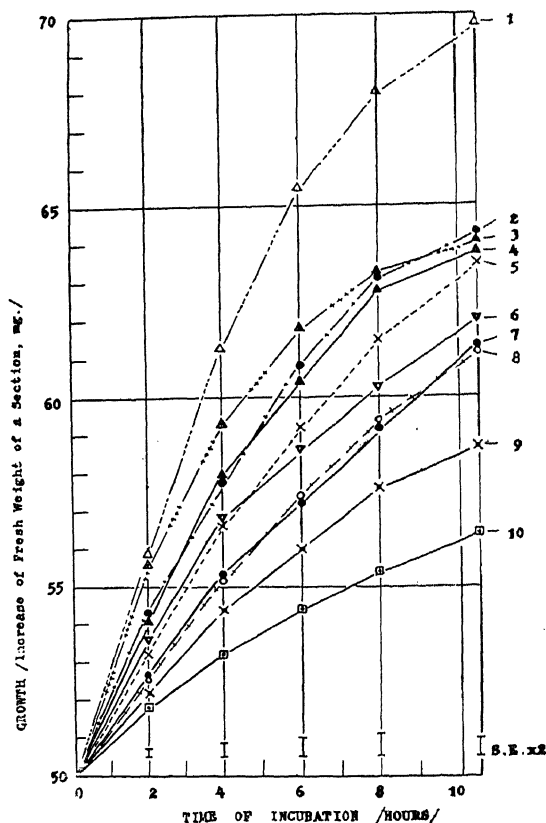


FIG. 1. Effect of IAA, Coumarin and  $GA_3$  on the CCC-induced retardation of growth of sunflower hypocotyl sections. 1 =  $\beta$ -IAA,  $1 \times 10^{-5}$  M; 2 = Coumarin, 200 p.p.m.; 3 = IAA + Coumarin; 4 = IAA + CCC; 5 =  $GA_3$ ,  $1 \times 10^{-5}$  M; 6 = IAA + CCC + Coumarin; 7 = CCC + Coumarin; 8 = Water; 9 = CCC +  $GA_3$ ; 10 = CCC,  $8.2 \times 10^{-3}$  M. Final concentrations of the growth regulators in mixtures are the same as in the case of single solutions. S.E. = standard error.

As it can be seen from the data of Fig. 1, CCC ( $8.2 \times 10^{-3}$  M.) markedly retards the longitudinal extension of sunflower hypocotyl sections. The inhibition is only partially decreased by  $1 \times 10^{-5}$  M.  $GA_3$ . On the contrary coumarin (200 p.p.m.) completely reverses the CCC-induced retardation: Growth rate of samples treated with the mixture (CCC + Coumarin) is identical

TABLE I

Effect of CCC, GA<sub>3</sub> and IAA on growth of the first leaf and rooting of maize seedling section\*

Parameter measured	Growth regulators added							
	0 Control	GA	IAA	CCC	GA+IAA	GA+CCC	IAA+CCC	GA+IAA+CCC
Mean length of the first leaf (mm.) $\pm$ standard deviation	8.6 $\pm$ 0.4	21.8 $\pm$ 1.1	7.9 $\pm$ 0.4	8.6 $\pm$ 0.2	21.5 $\pm$ 1.1	20.6 $\pm$ 0.5	8.9 $\pm$ 0.5	21.0 $\pm$ 1.3
Average length of single root (mm.)	8.24	0	8.54	4.00	0	0	5.60	0
Average quantity of roots per section†	1.2 $\pm$ 0.2	0 $\pm$ 0.1	1.6 $\pm$ 0.2	1.1 $\pm$ 0.0	0 $\pm$ 0.2	0 $\pm$ 0.2	1.4 $\pm$ 0.3	0 $\pm$ 0.2

\* Specific test for gibberellins<sup>13</sup> was used in the following modification: 17 mm. sections, 12 mm. above and 5 mm. below the node, were cut out of the etiolated maize (*Zea mays* L., bar Wir-42) seedlings in which the first leaf protruded a coleoptile sheath to 1-2 cm. Sections were floated on distilled water for 2 hours, divided into groups of ten, and planted into small glasses (3.2 cm.) containing 10 ml. of a nutrient medium of the following composition: sucrose, 3%; 0.01 M citric acid sodium phosphate buffer, pH 5.2; agar, 1%; and the growth regulators as indicated in Table I. Measurements were made after 40 hours of incubation at 26° C. in the dark, in an atmosphere of about 90% relative humidity.

Concentrations: CCC,  $8.2 \times 10^{-6}$  M; IAA,  $1 \times 10^{-6}$  M; GA<sub>3</sub>,  $1 \times 10^{-5}$  M.

† Roots shorter than 0.7 mm. were noted after "+".

with the growth rate of water treated sections (Fig. 1, lines 7 and 8, respectively). Indolyl-3-acetic acid (IAA) is the most effective in this respect (Fig. 1, line 4). It is striking that the reversing potentialities of IAA and coumarin are not additive; Growth rate of sections treated with the mixture of (IAA + CCC + Coumarin) is slightly increased as compared to the growth rate of the (CCC + Coumarin) treated sections, but is markedly lowered as compared to that of the (IAA + CCC) treated ones (Fig. 1, lines 6, 7 and 4, respectively). Coumarin decreases also growth of the IAA-treated sections despite the fact that IAA initially enhances growth of the coumarin-treated samples. Thus, IAA- and coumarin-induced growth phenomena are different in nature, though partially similar as inferred from the fact that both are potent to reverse the CCC-induced retardation of growth.

Since the data of Fig. 1 suggest that CCC does not act as "anti-gibberellin", a next series of analysis was conducted with the use of GA-sensitive test.<sup>13</sup> Data of Table I demonstrate that CCC does not specifically lower the GA-stimulated growth of the first leaf of maize seedling sections taken with the node and a part of mesocotyle. On the contrary, CCC to 50% decreases rooting and subsequent growth of roots in this test, i.e., it inhibits the auxin-stimulated processes.<sup>14</sup> It can be concluded, therefore, that CCC specifically retards or inhibits the auxin-mediated growth phenomena

and it should not be regarded as "anti-gibberellin".

Detailed results of experiments reported here and their full discussion will be presented elsewhere.

CCC was kindly supplied by Dr. A. H. Halevy, National and University Institute of Agriculture, Rehovot (Israel) and GA<sub>3</sub> by Mr. J. Roberts, Messrs. L. Light and Co., Ltd., Poyle Colnbrook (England), to whom my thanks are due.

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## LETTERS TO THE EDITOR

## MASS QUANTISATION OF ZERO-SPIN PARTICLES

STEPHENSON<sup>1</sup> has shown that mass quantisation of zero-spin particles occurs due to signature change from  $-2$  of the metric

$$ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2 \quad (1)$$

to  $+4$  of the metric

$$d\bar{s}^2 = c^2 dt^2 + dx^2 + dy^2 + dz^2 \quad (2)$$

by the following imaginary co-ordinate transformation

$$x \rightarrow ix, y \rightarrow iy, z \rightarrow iz. \quad (3)$$

The field equation of a zero-spin particle whose underlying metric is (1) is

$$\left[ \left( \frac{1}{c^2} \frac{\partial^2}{\partial t^2} - \nabla^2 \right) + \mu^2 \right] \psi = 0 \quad (4)$$

where  $\mu = mc/\hbar$  and  $\nabla^2$  is the Laplacian. The field equation whose underlying metric is (2) is clearly

$$\left[ \left( \frac{1}{c^2} \frac{\partial^2}{\partial t^2} + \nabla^2 \right) + \mu^2 \right] \phi = 0. \quad (5)$$

Equations (2) and (5) are invariant under orthogonal group of transformations whereas (1) and (4) are invariant under Lorentz transformations.

We suggest that instead of co-ordinate transformation (3), the following imaginary transformation

$$x \rightarrow ix, y \rightarrow iy, z \rightarrow iz, t \rightarrow it \quad (6)$$

be considered which gives the field equation as

$$\left[ \left( -\frac{1}{c^2} \frac{\partial^2}{\partial t^2} + \nabla^2 \right) + \mu^2 \right] \xi = 0. \quad (7)$$

Considerations of (4) and (7) lead to the same result as those if (4) and (5) are considered. (7) has its underlying metric as

$$ds'^2 = -c^2 dt^2 + dx^2 + dy^2 + dz^2 \quad (8)$$

the signature of which is  $+2$ .

Apart from giving the same result, the imaginary co-ordinate transformation (6) has the additional significance that the field equation as well as its underlying metric given by (7) and (8) respectively are invariant under Lorentz Transformation unlike the field equation and metric obtained by transformation (3) which are invariant under orthogonal group of transforma-

tions. It is natural, therefore, to prefer transformations (6) which lead to a kind of space-time where the equations of special relativity still hold and thus the original and final space-time possess a marked similarity which is not so if transformations (3) are considered.

Department of Metallurgy,

S. V. LELE.

Department of Physics,

A. V. LAGU.

Banaras Hindu University,

Varanasi, India, June 9, 1964.

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## DISSOCIATION CONSTANT OF LITHIUM ACETATE IN WATER

THE author, in his studies of ultrasonic absorption in aqueous solutions of inorganic acetates, was interested in the ionic dissociation constants of the acetates in aqueous solutions. While these constants are available in literature for alkali-earth acetates,<sup>1</sup> the same are not known for the alkali acetates as they come under the category of strong electrolytes.

Davies<sup>2</sup> has shown that some of the so-called strong electrolytes are incompletely dissociated at higher concentrations leading thereby to a finite dissociation constant. The author has made use of the method of Davies to test for complete or incomplete dissociation of alkali acetates in aqueous solutions. The conductivity data<sup>3</sup> (18° C.) and the activity coefficient data<sup>4</sup> (25° C.) required for the calculations are taken from standard sources. The coefficients of viscosity for these solutions are determined at 18° C. by means of an Ostwald viscometer. It is found that sodium and potassium acetates are completely dissociated even at higher concentrations. Calculation on lithium acetate, however, show that it is incompletely dissociated (Table I) leading to a finite dissociation constant of 3.3 at 18° C. which compares favourably well with that of 2.6 at 25° C. reported by Williams<sup>5</sup> from his study of the conductivity of salt mixtures.

TABLE I

*Aqueous solutions of lithium acetate (18° C.)*

Molar concentration (mole/litre)	0.1	0.2	0.5	0.7
Degree of dissociation	0.982	0.968	0.925	0.892
Dissociation constant	3.4	3.5	3.3	3.1

The author thanks Dr. C. W. Davies, Emeritus Professor at the University of Wales, for drawing the attention of the author to the work of Dr. Williams.

Department of Physics, M. SURYANARAYANA,  
University College of Science,  
Osmania University,  
Hyderabad-7, A.P., August 3, 1964.

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### N-SUBSTITUTED 1,4-DIHYDROQUINAZOLIN-4-ONES

IN view of the interesting muscle depressant and bronchodilatory properties reported<sup>1</sup> for some 1-substituted-1, 4-dihydroquinazolin-4-ones, the synthesis of the following N-substituted 1, 4-dihydroquinazolin-4-ones was undertaken.

The compounds listed in Table I were all prepared by the reaction of their corresponding

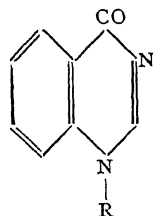


TABLE I

No.	R	m.p. in °C.	lit. m.p.	Nitrogen %	
				Found	Calc.
I	C <sub>6</sub> H <sub>5</sub>	182-84	..	12.81	12.61
II	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	193-95	203-5	11.56	11.87
III	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	158-61	..	10.83	11.11
IV	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (2)	171-72	..	10.75	11.11
V	C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> (4)	183-86	..	11.54	11.87
VI	C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> (2)	164-66	..	12.11	11.87
VII	C <sub>6</sub> H <sub>4</sub> Cl (2)	167-69	..	10.69	10.91
VIII	C <sub>6</sub> H <sub>4</sub> Cl (3)	165-67	..	10.74	10.91
IX	C <sub>6</sub> H <sub>4</sub> CF <sub>3</sub> (3)	135-37	..	9.84	9.65
X	C <sub>6</sub> H <sub>4</sub> COOH (2)	186-87	..	10.86	10.53
XI	C <sub>6</sub> H <sub>3</sub> CH <sub>3</sub> Cl (2,3)	204-06	..	10.06	10.35
XII	C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> (2,5)	161-62	..	9.31	9.62

N-substituted anthranilic acids with 3-4 equivalents of formamide in a sealed tube at 150-60° for four hours or with 6-8 equivalents of formamide at atmospheric pressure at 170-80°

for five hours. The N-substituted anthranilic acids required for the synthesis of the quinazolinones were all prepared by standard literature methods. The N-substituted-1, 4-dihydroquinazolin-4-ones were isolated in 20-40% yields as crystalline solids either from aqueous ethanol or from benzene-hexane.

2, 2'-Dicarboxydiphenylamine.—o-Chlorobenzoic acid (31.3 g.; 0.2 mole), o-aminobenzoic acid (27.4 g.; 0.2 mole), copper dust (2 g.) and sodium hydroxide (18 g.; 0.45 mole) were stirred and refluxed in amyl alcohol (150 ml.) for four hours. At the end of the reaction, a further quantity of sodium hydroxide (18 g.; 0.45 mole) in water (100 ml.) was added and the reaction product was steam distilled to remove amyl alcohol. The aqueous solution was then charcoaled and filtered hot; the filtrate on acidification to pH 5.5 with concentrated hydrochloric acid gave the title product. It was crystallised from aqueous dimethylformamide; m.p. 301-02° (reported<sup>2</sup> 295°). Found: N, 5.60; Calc. for C<sub>14</sub>H<sub>11</sub>NO<sub>4</sub>: N, 5.45%.

1-o-Carboxyphenyl-1, 4-dihydroquinazolin-4-one.—2, 2'-dicarboxydiphenylamine (5.1 g.; 0.02 mole) and formamide (7.2 g.; 0.16 mole) were heated together at 180° for five hours. The reaction product was stripped of excess of formamide *in vacuo*. The residue was rendered acidic with 4N hydrochloric acid and the product was filtered and crystallised from 50% acetic acid. It was recrystallised from aqueous ethanol; m.p. 186-87°; Found: N, 10.86; Calc. for C<sub>15</sub>H<sub>10</sub>N<sub>2</sub>O<sub>3</sub>: N, 10.53%.

1-Phenyl-1, 4-dihydroquinazolin-4-one.—N-phenyl-anthranilic acid (4.3 g.; 0.02 mole) and formamide (3.6 g.; 0.08 mole) were heated in a sealed pyrex tube at 150° for four hours. The product was boiled with sodium hydroxide solution (5%; 50 ml.) and extracted with benzene. The benzene extract was concentrated to 10 ml. and diluted with hexane to obtain the title product. It was crystallised from benzene-hexane; m.p. 182-84°. Found: N, 12.81; Calc. for C<sub>14</sub>H<sub>10</sub>N<sub>2</sub>O: N, 12.61%.

Scientific and Technical S. SOMASEKHARA.  
Research Division, G. M. SHAH.  
Sarabhai Chemicals, S. L. MUKHERJEE.  
Baroda, July 29, 1964.

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AMINO-ACIDS OF *PELTIGERA CANINA*

*Peltigera canina* (Linn.) Willd., a large spreading foliose lichen, found in the temperate Himalayas is considered useful as a food and tonic, and in liver complaints.<sup>1</sup> It has been earlier reported<sup>2</sup> that this lichen contains as much as 21% of protein with appreciable amounts of riboflavin and phosphorus. In continuation of our earlier report on the amino-acids of some Indian lichens,<sup>3</sup> we now give briefly the results of our study of the amino-acids, both free and combined, present in *Peltigera canina*.

The lichen from the Chamoli District in the Himalayan region was extracted for its amino-acids, free and combined, and the identification done by means of descending paper chromatography in different solvent systems using Whatman No. 1 filter-paper and ninhydrin for the development of the colour as reported earlier,<sup>3</sup> except that 14% aqueous barium hydroxide was used for hydrolysis instead of 6N NaOH. Semi-quantitative assessment of the concentration of the different amino-acids was also made from the visual scoring of the colour intensity of the spots developed side by side with known quantities of authentic amino-acids (Table I).

TABLE I

Amino-acid composition of *Peltigera canina*

Sl.No.	Amino-acid	Free	Combined
1	Leucine*	.. ++	++
2	Isoleucine*	.. +	++
3	Phenylalanine*	.. +	+
4	Tyrosine	.. +	+
5	Tryptophan*	.. -	+
6	Alanine	.. ++	+++
7	Threonine*	.. ++	++
8	Serine	.. -	++
9	Glycine	.. ++	+++
10	Arginine	.. +	+
11	Lysine*	.. -	+++
12	Valine*	.. ++	++
13	Methionine*	.. +	+

\* Essential amino-acids.

Free amino-acids: Each (+) indicates about 3 mg. in 100 g. of the lichen.

Combined amino-acids: Each (+) indicates about 100 mg. in 100 g. of the lichen.

It is interesting to note that *Peltigera canina* contains 9 free amino-acids of which 5 are essential, and the acid and alkali hydrolysates contain 4 more amino-acids of which 3 are essential (Table I). Thus, the food value of the lichen and also its possible usefulness in liver complaints appear to be due to the high protein content and the essential amino-acids

present, methionine having some special significance.

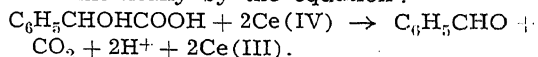
We thank Prof. T. R. Seshadri for his kind interest in this work and the lichen sample, and the Principal, Medical College, Pondicherry, for encouragement.

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DETERMINATION OF MANDELIC ACID  
BY OXIDATION WITH CERIUM (IV)  
SULPHATE

BENRATH AND RULAND<sup>1</sup> first showed that  $\alpha$ -hydroxy acids were oxidised by cerium (IV) sulphate. Willard and Young<sup>2</sup> oxidised some of the  $\alpha$ -hydroxy acids to formic acid stage but their determinations have been worked out very recently. Sharma and Mehrotra<sup>3</sup> have re-examined the conditions for the oxidation of various hydroxy compounds with cerium (IV) sulphate and showed that these compounds can be completely converted to  $\text{CO}_2$  stage by refluxing with cerium (IV) sulphate in the presence of concentrated  $\text{H}_2\text{SO}_4$ . They suggested that complete oxidation of the above compounds provided satisfactory method for their quantitative estimations. Recently Duke and Smith<sup>4</sup> also suggested a method by which some  $\alpha$ -hydroxy acids can be estimated by cerium (IV) perchlorate by the back titration method. In a more recent communication Sengupta and Aditya<sup>5</sup> assigned a new method for the quantitative estimation of pyruvic acid by oxidation with cerium (IV) perchlorate. But even now, no method has been developed for the determination of mandelic acid based on its oxidation by cerium (IV) salts although the kinetics of the oxidation of mandelic acid has been studied by Sengupta *et al.*<sup>6</sup> where the reaction has been represented stoichiometrically by the equation:



In this study, a new method for the estimation of mandelic acid has been suggested.

## EXPERIMENTAL

Ceric ammonium sulphate was (G.R., E. Merck's product and the solution of the salt in  $\text{H}_2\text{SO}_4$  was directly prepared, Mandelic



acid used was Mallinckrodt product and the solution of the acid has been prepared by dissolving the acid in water and its concentration was determined by titration with standard alkali. Cerium (IV) ion was determined by the iodometric method.<sup>7</sup>

In order to determine the strength of mandelic acid, the hydroxy acid was left mixed with about five times known excess of cerium (IV) sulphate for 24 hours. Temperature of the solutions was maintained at 30°-35° C. The acidity of the solution was adjusted by the addition of H<sub>2</sub>SO<sub>4</sub> and varied between the limits 0.25 N-0.75 N. In each case the total volume was kept fixed, i.e., 40 c.c. by the addition of water. After 24 hours, excess of KI was added to the cerium (IV) solution and the liberated iodine was then estimated by a standard sodium thiosulphate using starch as an indicator.<sup>7</sup> The results obtained by cerimetric method agreed well with those by acidimetry within  $\pm 0.5$ . The determinations of lactic, tartaric, malic and glycolic acid were then tested by this method but the results obtained were variable, hence the method is not applicable in these cases.

The results of some determinations of mandelic acid by the recommended method are given in Table I.

TABLE I  
Titration of mandelic acid by cerium (IV)  
sulphate

← Concentration of mandelic acid →

No.	Acidimetry	Cerimetry	Error (%)
1	0.00489 N	0.00491 N	-0.4
2	0.00733 "	0.00734 "	+0.1
3	0.00978 "	0.00976 "	-0.2
4	0.0122 "	0.0122 "	0.0
5	0.01465 "	0.0147 "	+0.3
6	0.02445 "	0.0244 "	-0.2
7	0.00366 "	0.00366 "	0.0
8	0.006125 "	0.00610 "	-0.4

The authors express their deep sense of gratitude to Professor B. N. Ghosh for providing laboratory facilities and keen interests during the work.

Dept. of Physical Chem., K. K. SENGUPTA.\*  
University Colleges of S. D. BHATTACHARYA.  
Science and Technology, J. BANERJEE.  
92, Acharya P.C. Road,  
Calcutta-9, India, July 18, 1964.

\* Present address: 212, Prince Anwar Shah Road, Calcutta-45, India.

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## PRESERVATION OF COCONUT NEERA BY CONCENTRATION

NEERA, the sweet juice from the date palm or the coconut palm has been tapped for consumption by man. Its conversion to gur, sugar or vinegar has been an old village industry. From the nutritional point of view, it is a wholesome beverage with a high nutritive value since it is rich in sugars, vitamins and certain amino-acids. Its composition, however, makes it susceptible to microbial attack particularly by the yeast and bacteria. Normally it ferments into toddy in about eight to nine hours, after which acetification takes place.

Though preservation of neera in its original state has attracted considerable amount of interest, it has so far not been possible to preserve it for extended periods without the addition of preservatives or by heat treatment.<sup>2,4,5</sup> This note reports the results of studies carried out to preserve neera by concentration at low temperatures and to determine the effect of concentration on its quality and flavour.

*Material and Methods.*—Coconut neera was taken up for the study. Clean earthenware pots of about two litres capacity were thoroughly cleaned, sterilized and tied to the palm inflorescences in the evening. They were brought down from the trees the next morning, the juice filtered in cold and brought over to the laboratory. It was then concentrated in a thin film line concentrator under 25 lb. of vacuum and a steam pressure of 5 lb. per square inch.

Total solids and ash were determined according to the methods of A.O.A.C.<sup>1</sup> total nitrogen by the micro-Kjeldahl method, sugars by the method of Harman and Shaffer<sup>3</sup> and total vitamin C by titration against 2 : 6 dichlorophenolindophenol. Total bacterial and yeast counts were determined microscopically with a haemocytometer.

The concentrated material was subjected to the following treatments.

1. Addition of sulphur dioxide at 350 ppm.
2. Addition of sodium benzoate at 750 ppm.
3. Addition of 350 ppm. of sulphur dioxide and 400 ppm. of benzoate.
4. pH adjusted to 10 with lime-water.
5. pH adjusted to 10 with lime-water and pasteurized at 60° for ten minutes.
6. Pasteurized at 60° for ten minutes.
7. Control—No treatment.

**Results.**—The average chemical composition of fresh neera as determined in the laboratory is given in Table I.

TABLE I

*Chemical composition of fresh neera*

Total solids (g.)	..	16.000	per 100 ml.
" Ash (g.)	..	0.303	"
" Nitrogen (g.)	..	0.023	"
" sugars (as reducing) (g.)	..	15.850	"
Free reducing sugars (g.)	..	0.770	"
Total vit. C. (g.)	..	0.012	"
" Bacterial Count	..	20 × 10 <sup>6</sup>	cells/ml.
" Yeast Count	..	8 × 10 <sup>6</sup>	"
pH	..	5.92	"

It was seen that on keeping overnight, all the treatments except Nos. 5 and 6 had undergone fermentation. Addition of lime to the collecting pots to prevent fermentation has been an old practice. Though pasteurization of the lime treated concentrate prevented fermentation, it led to the development of an undesirable colour and odour. It was only the material without lime that kept well without any off-flavour or colour. This material was bottled after concentration and stored under room temperature conditions (23–27° C.) for a period of three months. Analysis of this stored material was carried out at monthly intervals and the results are presented in Table II.

TABLE II

*Composition of the neera concentrate at different intervals*

Constituents	Interval in days				
	0	30	60	90	
Total solids	.. 59.60	57.10	58.20	57.90	} Gm./ 100 ml.
" ash	.. 1.03	1.08	1.03	1.01	
" nitrogen	.. 0.07	0.07	0.070	0.07	
" sugars (as reducing)	.. 54.30	53.10	53.60	53.50	
Free reducing sugars	10.80	11.71	11.89	13.39	
Total vit. C.	.. 0.04	0.04	0.04	0.04	}
pH	.. 5.38	5.26	5.32	5.40	

It is seen from Table II that there is practically no loss of any constituent during the pro-

cess of concentration nor during the process of storage, for over three months at room temperatures. Organoleptic evaluation of the re-constituted concentrate to the original level of neera showed that it still retained the flavour and taste of fresh neera. The concentrate thus prepared could well be used in the preparation of pharmaceutical syrups and in fruit industry since it is rich in sugars.

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Central Food Technological Research Institute,  
Mysore, July 3, 1964.

PATRIC TAURO.\*

G. RAMA RAO.

\* Present address: Department of Bacteriology, University of Wisconsin, Madison, Wisconsin.

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## STUDIES IN TERPENES

### Part XIX. Transformations of Terpinen-4-ol

RECENTLY it was reported<sup>1</sup> that the reactions of terpinen-4-ol (I) with sulphuric, oxalic and o-methyl benzoic acids gave varying proportions of α-terpinene (II), γ-terpinene (III) and p-cymene (IV). This has prompted us to place on record our findings on the behaviour of this alcohol towards boric acid, alumina, fused potassium hydrogen sulphate, 20% aqueous phosphoric acid and iodine (Table I).

Terpinen-4-ol can theoretically lose a molecule of water to give either II, III or terpinolene (V). The results indicate that II is the preferred dehydration product of I; this is followed by III. Apparently I does not obey Saytzeff rule<sup>2</sup> to give terpinolene.

That the p-menthadienes formed can further undergo hydrogen transfer of the type:  $2C_{10}H_{16} \rightarrow C_{10}H_{18} + C_{10}H_{14}$ <sup>3</sup> is clearly demonstrated by reaction (5) using iodine, which afforded p-3-menthene and p-cymene. A similar disproportionation would account for the production of IV in other runs also.

Finally, 1 : 4-cineole was obtained in small amounts by treatment of I with 20% phosphoric acid (Reaction 4). This oxide undoubtedly

TABLE I  
Transformations of terpinen-4-ol\*

Reaction		1 <sup>1</sup>			2 <sup>2</sup>			3 <sup>3</sup>		
Oil fractionated† g.		17			18.5			17		
Pressure mm.		738.8			736.5			737.5		
No.	Fraction b.p. °C.	Yield %	$n_D^{20}$	Compounds Identified	Yield %	$n_D^{20}$	Compounds Identified	Yield %	$n_D^{20}$	Compounds Identified
1	162-165	..	..	..	5.0	1.4705	$\alpha$ -Terpinene <sup>6</sup>	..	..	..
2	165-169	..	..	..	4.0	1.4708	"	..	..	..
3	169-171	..	..	..	5.0	1.4755	"	..	..	..
4	171-173	15.0	1.4753	$\alpha$ -Terpinene <sup>6</sup>	5.5	1.4763	"	..	..	..
5	173-175	17.0	1.4773	"	22.5	1.4787	"	14.0	1.4772	$\alpha$ -Terpinene <sup>6</sup>
6	175-178	38.0	1.4781	"	31.5	1.4813	"	29.5	1.4785	"
7	178-181	12.5	1.4795	"	7.5	1.4868	"	..	..	..
8	181-184	6.5	1.4832	$\gamma$ -Terpinene <sup>7</sup>	5.0	1.4921	$\gamma$ -Terpinene <sup>7</sup>	..	..	..
9	Residue steam distilled	8.0	1.4897	Terpinen-4-ol <sup>8</sup>	9.0	1.4990	"	52.0	1.4799	Terpinen-4-ol <sup>8</sup> †
% <i>p</i> -Cymene‡		..	15.3	..	..	14.6	..	..	7.3	..

Reaction		4 <sup>4</sup>			5 <sup>5</sup>		
Oil fractionated† g.		21.4			17		
Pressure mm.		737.4			738.7		
No.	Fraction b.p. °C.	Yield %	$n_D^{20}$	Compounds Identified	Yield %	$n_D^{20}$	Compounds Identified
1	162-165	..	..	..	2.0	1.4480	3-Methene‡
2	165-169	..	..	..	8.0	1.4536	"
3	169-171	..	..	..	10.5	1.4625	"
4	171-173	4.8	1.4673	$\alpha$ -Terpinene <sup>6</sup> 1 : 4 Cineole†	26.0	1.4690	..
5	173-175	14.0	1.4699	"	40.5	1.4812	..
6	175-178	38.4	1.4716	"	..	..	..
7	178-181	15.2	1.4761	$\alpha$ -Terpinene <sup>6</sup>	..	..	..
8	181-184	12.0	1.4826	$\gamma$ -Terpinene <sup>7</sup>	..	..	..
9	Residue steam distilled	6.0	1.4842	"	7.5	1.4918	..
% <i>p</i> -Cymene‡		..	4.2	..	..	31.2	..

\* (Supplied by L. Light & Co., Ltd. b.p. 210-214°,  $n_D^{20}$  1.4800,  $[\alpha]_D^{20}$  -25.8°).

† Using Todd Precise Fractionation Assembly.

‡ Recognised by infrared analysis.

§ For method of estimation, see ref. (5).

<sup>1</sup> One hour pyrolysis of terpinen-4-ol (30.85 g.) with boric acid (12.4 g.). Yield 24.0 g.,  $n_D^{20}$  1.4795,  $d_4^{30}$  0.8508,  $[\alpha]_D^{30}$  -5.3°.<sup>2</sup> Terpinen-4-ol (32.5 g.) passed through alumina catalyst (Harshaw, Al-1404 T  $\frac{1}{8}$ " ) heated to 300° and at a liquid hourly space velocity 0.35. Yield 26.5 g.  $n_D^{20}$  1.4810,  $d_4^{30}$  0.8458,  $[\alpha]_D^{30}$   $\pm$  0°.<sup>3</sup> One hour refluxing of terpinen-4-ol (30.85 g.) with fused potassium bisulphate (60.70 g.) Yield 26.5 g.,  $n_D^{20}$  1.4832,  $d_4^{30}$  0.8504,  $[\alpha]_D^{30}$  -10°.<sup>4</sup> Terpinen-4-ol (30.85 g.) refluxed with 20 per cent. aqueous phosphoric acid (19.6 g.) for 20 hours. Yield 26.5 g.,  $n_D^{20}$  1.4746,  $d_4^{30}$  0.8578,  $[\alpha]_D^{30}$   $\pm$  0°.<sup>5</sup> Distilled terpinen-4-ol (40.85 g.) from iodine (0.45 g.) during 2 hours. Yield 33 g.,  $n_D^{20}$  1.4717,  $d_4^{30}$  0.8437,  $[\alpha]_D^{30}$   $\pm$  0°. Derivatives were confirmed by mixed m.p. determination: <sup>6</sup> Nitrosite, m.p. 155°; <sup>7</sup> Nitrosate m.p. 116°;<sup>8</sup> Hancox and Jones derivative<sup>4</sup> m.p. 105-106°.

originated by dehydration of the intermediate 1:4-terpin which is formed from I by hydration. Further work is in progress.

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Department of Chemistry, K. K. SUGATHAN.\*  
Christian Medical College, JAMES VERGHESE.  
Vellore, N. Arcot, July 2, 1964.

\* Present address: Department of Chemistry, Sree Kerala Varma College, Trichur.

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## OBSERVATIONS ON THE EFFECTS OF PURINES AND ATP ON HEART

THE contractile activity of heart is known to depend on acetylcholine which requires adenosinetriphosphate (ATP) for its synthesis. ATP-ase and cholinesterase have been reported to be inhibited by caffeine.<sup>1-3</sup> Bose *et al.*<sup>2</sup> observed the depressant effect of a number of purine bases on the cholinesterase activity of heart, indicating thereby, that the basic molecule might be responsible for this action. With a view to elucidate this point, the relationship between xanthine, ATP and ADP has been studied on frog heart, to find out, if the presence of one type of purine would modify the response or function of others.

Modifying influences of ATP and ADP on caffeine; theophylline and caffeine on ATP and ADP, and the mutual effects of ATP and ADP have been studied by the perfusion of the isolated frog heart.

It was observed that ATP, ADP and caffeine stimulated the heart and prior administration of ATP potentiated the response to caffeine, while ADP was completely ineffective in this respect. Prior administration of ADP enhanced the effect of ATP while the latter inhibited subsequent responses to ADP (Table I),

TABLE I

Effect of ATP, ADP and Caffeine on isolated frog heart

The observations are the averages of ten readings in each case

Drug	% increase in response $\pm$ SD
ATP (100 $\mu$ g.)	.. 43.5 $\pm$ 3.9
ADP (200 $\mu$ g.)	.. 62.5 $\pm$ 5.8
Caffeine (400 $\mu$ g.)	.. 10.1 $\pm$ 2.1
Caffeine (400 $\mu$ g.) after ATP (100 $\mu$ g.)	18.2 $\pm$ 1.9
Caffeine after ADP (200 $\mu$ g.) (400 $\mu$ g.)	9.8 $\pm$ 2.4
ATP (100 $\mu$ g.) after (ADP 200 $\mu$ g.)	66.1 $\pm$ 7.2
ADP (200 $\mu$ g.) after ATP (100 $\mu$ g.)	39.1 $\pm$ 4.3

While the action of ATP was increased after perfusion of caffeine, that of ADP remained unaffected (Fig. 1).

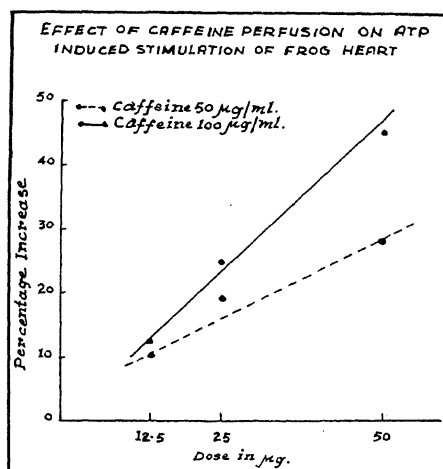


FIG. 1

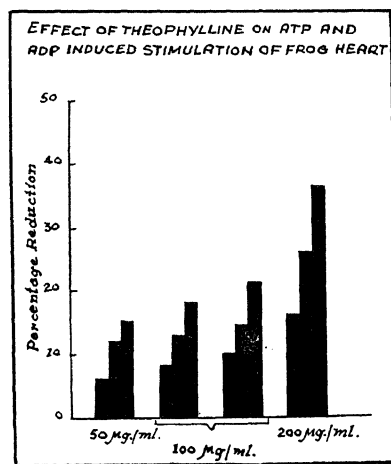


FIG. 2

Theophylline produced the opposite effect of Caffeine and the stimulant action of both ATP and ADP (12.5, 25 and 50 µg. of each), but Theobromine was completely ineffective in this respect (Fig. 2).

Dept. of Pharmacology,  
M.G.M. Medical College,  
Indore, M.P., June 2, 1964.

B. C. BOSE.  
R. VIJAYVARGIYA.  
A. W. BHAGWAT.  
N. M. ROY.

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Geology Department,  
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M. R. SAHNI.  
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### ADDITIONAL FOSSILS FROM THE LOWER PALAEOZOIC OF THE KASHMIR HIMALAYA

THE note records certain fossil occurrences in addition to those already reported by the authors from the Lower Palæozoic of the Kashmir Himalaya.<sup>1</sup> The study is based on material collected by the junior author during the field season 1963.

The following species have been provisionally identified :

Cystidea :

*Caryocrinus* sp.  
*Cheirocrinus* sp.

Corals :

*Stylarea* sp.  
*Streptelasma* sp.  
*Lindstrocmia* of Subplicata Mc'roy.  
*Pacecolus melliflus* Salteri.

Bryozoa :

*Diplotrypa* aff. *sedavensis* Reed.

Crinoids :

*Schizocrinus* sp.(?)  
Crinoid stems.

Gasteropods :

*Cyclonema* sp.  
*Cornulites* sp.

Trilobites.

*Calymene kashmiricus* sp. nov.  
*Phacops kashmiricus* sp. nov.  
*Phacops naubugensis* sp. nov.  
*Encrinurus kashmiricus* sp. nov.  
*Illænus kashmiricus* sp. nov.

Brachiopods :

*Orthis (Dinorthis) flabeilulow* Sow.  
*Orthis (Dalmanella) chaungzonenses* Reed,  
*Orthis testudinaria* var. *shanensis*.  
*Rafinesquina imbrex* Pander.  
*Plectambonites sericea* Sow.  
*Conchidium bilouclare* Linn.

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### STRATIGRAPHICAL SEQUENCE IN SINGHBHUM DISTRICT, BIHAR

BASED on the author's acquaintance of several years with the geology of Singhbhum, an attempt is made at correlating the major rock units described in the earlier literature (Jones, 1934; Dunn, 1939, 1940; Dunn and Dey, 1942) and to show that the mapping as well as the interpretation of the geology by the Geological Survey of India is fundamentally sound.

Dunn (1940) showed clearly the existence of a sequence younger than the Iron Ore Series, which he called the Kolhans. He also indicated that, away from the granite border, the Kolhans were intimately and intricately folded-in with the Iron Ore Series rocks. The Older Metamorphics of Jones were shown to comprise mainly Iron Ore Series rocks, intruded by the Singhbhum granite, while the Newer Dolerite of Jones was shown to consist mainly of lavas belonging to the Iron Ore sequence, and partly of ultrabasic rocks. This work elucidated the geology of North and South Singhbhum.

Since the revision mapping of Dunn (1940) was not carried into Eastern Singhbhum, certain doubts yet remained. Meanwhile, the mapping of the Dhanjori basin in Dhalbhum, comprising lavas, conglomerates and quartzites, created additional complications. Since the mapping of the Kolhans basin had stopped south of Chaibasa, the geological map showed the Kolhans only to the south of Chaibasa, while the counterpart of the same sandstones, occurring to the north of Chaibasa, were yet relegated to the Iron Ore sequence, in accordance with the earlier mapping based on the stratigraphic units established by Jones (1934). Meanwhile, the sandstone, quartzites, conglomerates and breccia, associated with the Dhanjoris, were mapped further to the west of the basin along the thrust zone, and doubtfully assigned to the Iron Ore sequence and also partly to the newly created Dhanjori sequence which was considered to be younger than the Iron Ore stage,

TABLE I  
Table of correlation

Sequence of Rock Units	Equivalents in Dunn's terminology with remarks
1. Dolerite ..	<i>Newer Dolerite</i> —At places altered to amphibolites
2. Conglomerate-sandstones (quartzite,) arkose, limestone, phyllite (shales) ..	<i>Kolhan</i> —Including the sandstone-conglomerate occurring at the base of the Dhanjori. and the arkose-conglomerate found along the western extension of the thrust zone
3. Granite ..	<i>Singbhum and Chakradharpur</i> —Granites, granodiorite
4. Ultrabasic rocks and related rock types—gabbro, serpentinite, anorthosite, and granophyre ..	<i>Ultrabasic</i> —Comprising part of the "Older metamorphics" of Jones and certain schistose inclusions in the granite. The gabbro-granophyre is considered to be a differentiated residuum of tholeiite magma of late Iron Ore age
5. lavas, tuffs, agglomerates, greywacke, cherts, B.H.Q., and phyllite ..	<i>Iron Ore Series</i> —Lavas, Ongabira traps, Dalma and Dhanjori lavas, and sediments of the Iron Ore and Chaibasa stages. The phyllites grade into mica schists and show the development of garnet, staurolite, kyanite, as found in the Chaibasa stage in north Singbhum. It is, however, doubtful whether the Chaibasa stage is in reality older than the Iron Ore stage of the Iron Ore Series. Part of the 'Older Metamorphics' of Jones will also be included here

Examination of the thrust belt, from the western end of the Dhanjori basin westwards for about 30 miles, shows that the sandstone conglomerate and breccia (arkose), found to the north of Chaibasa and along the thrust zone, belong actually to the Kolhan sequence, and that the same conglomerate quartzite is found beneath the lavas at the base of the Dhanjori, due to thrusting. The Dhanjori lavas, in fact, belong to the Iron Ore sequence even as the Dalma, Ongabira and Naomundi lavas, do.

The pattern of the outcrops of the ultrabasic rocks shows the influence of structural control. These basic differentiates, possibly of a tholeiitic magma, were emplaced in structures within the Iron Ore Series. Isoclinal and recumbent folding together with the associated thrusts and faults, described by Dunn (1940) and Jones (1934), show that the structure of the main horse-shoe-shaped Iron Ore basin comprises a sheaf of peel thrusts. It also appears that the broad structure of the Dhanjori basin is also similar.

Based on the above observations, the correlation which emerges as the most satisfactory is given in Table I.

As a consequence of the highly disturbed nature of the area, the close intermingling, and similarity of the rock types belonging to various stratigraphical units, any studies based on radioactive dating, should be done with utmost care. This is also true for fabric studies, whether micro or macro. Sampling for age determinations is bound to be erroneous unless one is thoroughly familiar with the area; and the intensity of sampling is of prime importance.

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#### A NOTE ON THE PANCREAS AND THE DIGESTIVE ENZYMES OF FISH

THE literature on the digestive system of fish shows that not much attention has been paid to the study of pancreas and liver there being only a few scattered references. This is also the case with regard to the physiology of digestion, particularly in Indian fishes. This note gives a preliminary account of work in progress on these aspects. Three fish *Mystus gulin* (omnivorous), *Tilapia mossambica* (herbivorous) and *Megalops cyprinoides* (carnivorous) have been investigated.

Macallum<sup>1</sup> was the first to report in a teleost, *Amiurus catus*, the presence of pancreas embedded in the liver. In the three fish studied the pancreas is diffuse. In *Tilapia mossambica* there is a hepatopancreas while in the other two the pancreas does not penetrate into the liver. Separate bile and pancreatic ducts have also been noticed.

The endocrine pancreas (islets of Langerhans) consists of primary and secondary islets. Of all the stains used, the Gomori modification of the Mallory-Heidenhain azan stain gives excellent results on tissues fixed in Helly's fluid. The A cells show fine red granules in the

cytoplasm, the B cells present larger orange granules and the cytoplasm of D cells stains pale blue. The number and position of these cells in the islets of these fish are varied.

For the study of enzymes acetone dried and distilled water extracts were made as per standard methods. The activity of enzymes on carbohydrates was determined by quantitative and qualitative methods. The products of protein digestion were estimated by Sørensen's formol titration method and the products of fat digestion by the direct titration of fatty acid formed with sodium hydroxide. In all the experiments the pH of the experiments was controlled by suitable buffers.

The results of the experiments showed that *Mystus gulio* and *Megalops cyprinoides* have very strong proteolytic enzymes capable of splitting different types of proteins (casein, fibrin, gelatin). The enzyme system of *Tilapia mossambica* is very effective on carbohydrates hydrolysing a variety of carbohydrates. These results are in agreement with those of Al-Hussaini,<sup>2</sup> Kenyon<sup>3</sup> and Vonk<sup>4</sup> showing that there is a correlation between diet and the nature of enzymes. The anatomy and histology of the alimentary canal of these three fish in relation to differences in their feeding habits were previously given.<sup>5-7</sup>

The author is indebted to Prof. N. Ramalingam for encouragement.

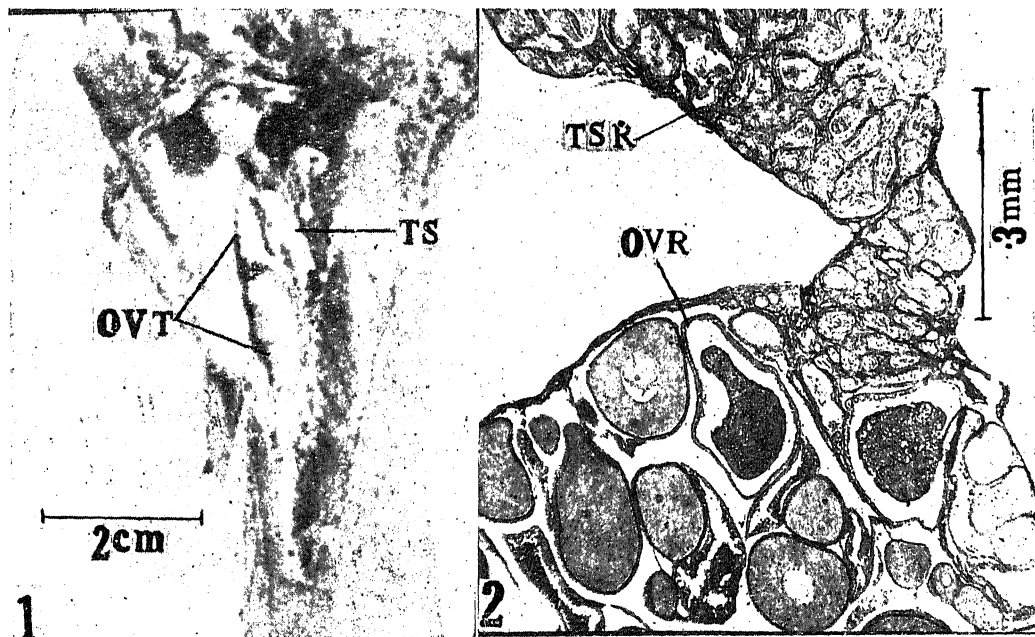
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### AN INSTANCE OF HERMAPHRODITISM IN THE CATFISH, *CLARIAS BATRACHUS* (LINN.)

OCCASIONAL hermaphroditism has been reported in several species of teleosts.<sup>1-6</sup> The present case is reported in an Indian catfish *Clarias batrachus*.

During the course of investigations on the gonads of *Clarias batrachus*, an interesting case of hermaphroditism has been observed. A male fish measuring 224 mm. in length when dissected exhibited the presence of an enlargement in the posterior region of the testis of the left side (Fig. 1). This enlargement on further examination turned out to be an ovary (Fig. 2).



FIGS. 1-2. Fig. 1. Photograph of the dissected fish showing the gonads: TS=testis; OVT=ovo-testis. Fig. 2. Photomicrograph of the section of ovo-testis: TSR=testicular region; OVR=ovarian region.

A section of the ovo-testis shows that both the testicular and ovarian regions are enveloped by a common sheath and that the two regions meet by a narrow connection. The testicular region shows crypts full of sperms while the ovarian region shows ova in various stages of development.

The particulars of the gonads are given in Table I.

TABLE I

Left gonad (ovo-testis)				Right gonad (testis)	
Ovarian portion		Testis portion		Testis portion	
Length mm.	Breadth mm.	Length mm.	Breadth mm.	Length mm.	Breadth mm.
13	6	16	3	19	2.5

In the earlier cases reported (*Barbus stigma*,<sup>4</sup> *Lebistes reticulatus*<sup>5</sup> and *Mystus vittatus*<sup>6</sup>), the testicular and ovarian tissues of the ovo-testis are mixed up and scattered without any regular order. In the present case, however, the testicular and ovarian regions of the ovo-testis are clearly demarcated. The testicular part lies on the anterior side and narrows down posteriorly to enter the ovarian region.

Grateful thanks are due to Dr. H. Swarup for his keen interest and guidance.

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### ON THE OCCURRENCE OF CARBOHYDRATE IN THE EPICUTICLE OF SPIDERS

It is known that the epicuticle of spiders is devoid of chitin, although in some arachnids such as the scorpion, *Palamneus swammerdami*, a chitin component in the epicuticle has been reported by Krishnan.<sup>1</sup> Further, in *Tegenaria domestica* Sewell<sup>2</sup> has reported the occurrence of a cement layer which Beament<sup>3</sup> from studies on cockroach epicuticle, suggested, may contain a shellac-like substance probably a carbohydrate.

However, the chemical nature of the cement layer in the spider, investigated by Sewell<sup>2</sup> is not known for certain. Richards<sup>4</sup> suggested that a carbohydrate constituent may be present in the epicuticle of insects as revealed by PAS test. There has been no report of the presence of a carbohydrate, patent or masked in the epicuticle of spiders. It is therefore of interest to note its presence in the non-chitinous epicuticle of the spiders investigated in the course of the following study.

In the sclerite region the epicuticle and the spines of the spiders belonging to the genera *Stegodyphus*, *Nephila* and *Argiope* show resistance to hot concentrated alkali treatment, involved in chitosan test. This property is usually attributed to the presence of chitin.<sup>5</sup> But in the present instance, the characteristic colour reaction with iodine sulphuric acid indicative of chitin has not been obtained. A similar observation has been reported by Sewell<sup>2</sup> in the epicuticle of the spider *Tegenaria domestica* and by Krishnakumaran<sup>6</sup> in *Argiope catenulata*. It was felt that the material in the spider epicuticle referred to above, responsible for the resistance to alkali treatment, may not be chitin.

Sewell<sup>2</sup> considered that the epicuticle of *Tegenaria domestica* could be presumed to be equivalent to the outer epicuticle of *Sarcophaga larvæ*<sup>7</sup> and the highly resistant paraffin epicuticle of *Periplaneta*<sup>8</sup> both of which survive after potash treatment. However, in the spiders examined above, that a lipid fraction may not be responsible for the resistance to hot concentrated potash treatment is suggested by the negative reaction to Sudan IV and Sudan black B after potash treatment. It is suggested that the alkali-resistant substance may be non-chitinous and non-lipid. With a view to investigate further, the nature of the substance, transverse sections of the cuticle of these spiders have been treated with Periodic acid Schiff's reagent. The whole cuticle uniformly showed purplish-red colour. When sections of the cuticle are treated with saliva before application of the PAS test, the epicuticle showed a less intense colour, while the rest of the cuticle was not affected. This observation which may suggest the presence of a carbohydrate other than chitin in the epicuticle is supported by a chromatographic analysis of the epicuticle of the spider *Stegodyphus*, following the method of Giri and Nigam<sup>9</sup> and Trevelyan et al.<sup>10</sup> The chromatograms showed a band, the R<sub>f</sub> value of which tallied with that of sucrose, and also corresponded to pure sucrose, used as control.



That this band is due to sucrose was further confirmed by testing the spot in question by resorcinol-hydrochloric acid test,<sup>11</sup> which was positive.

In this context it is of interest to recall Anderson's<sup>12</sup> observation that disaccharides like sucrose, resist alkali treatment. The degree of resistance to alkali is said to vary according to time, temperature and pH.<sup>13</sup> In the light of the above observations it may appear reasonable to suggest that the resistance to strong alkali noted in the epicuticle of spiders, mentioned above may be due to the presence of sucrose which occurs probably in bound form.

I have great pleasure in acknowledging my deep indebtedness and gratitude to Professor G. Krishnan. My thanks are due to the University of Madras for the award of a research scholarship, during the tenure of which this study was carried out.

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#### PLANT PARASITIC NEMATODES FOUND IN THE ROOT ZONES OF TOBACCO

NEMATODES are known to be serious pests of tobacco and in some countries these are almost limiting factors to successful cultivation of this crop (Graham, 1951). In the host index compiled by Goody *et al.* (1958), species of *Aphelelenchus*, *Ditylenchus*, *Heterodora*, *Meloidogyne*, *Paraphelenchus*, *Rotylenchus*, *Tylenchorhynchus* have been reported to be associated with *Nicotiana tabacum* L.

In India Desai *et al.* (1963) have reported severe stunting of tobacco plants in Gujarat with markedly reduced root systems which they

suspected to be due to nematodes. In a preliminary effort to determine what parasitic nematodes are associated with tobacco, soil and root samples drawn from the root zones of plants growing in certain fields in Gujarat, Mysore and Uttar Pradesh, were examined.

For isolation of vermiform nematodes modified Baermann funnel technique (Christie and Perry, 1951) was employed. The sedentary forms were teased out from the roots under a stereoscopic binocular. Freshly prepared mounts were used for microscopic examinations for identification. The species of *Meloidogyne* were identified by examining the perineal patterns of the adult females with the help of a key proposed by Taylor *et al.* (1955). For other identifications, publications of Mai and Lyon (1962), Jenkins (1959), Perry (1960) and Sher and Allen (1953) were referred. The parasitic nematodes thus found are listed in Table I.

TABLE I  
Plant parasitic nematodes found in root zones  
of tobacco

Location	Class of tobacco	Nematodes
Anand, Gujarat	Bidi tobacco	<i>Hoplotaimus angustallatus</i> Whitehead <i>Helicotylenchus erythrine</i> (Zimmerman) Golden <i>Tylenchorhynchus latiss</i> Jenkins <i>Pratylenchus</i> <del>see</del> Graham <i>Pratylenchus thornei</i> Sher and Allen <i>Meloidogyne arenaria</i> (Neal) Chitwood <i>Rotylenchus reniformis</i> Linford & Oliveira <i>Trichodorus minor</i> Coll- ram
Hunsur, Mysore	Flue cured virginia & Bidi tobacco	<i>Helicotylenchus erythrine</i> (Zimmerman) Golden <i>Pratylenchus</i> spp. <i>Meloidogyne arenaria</i> (Neal) Chitwood <i>Rotylenchus reniformis</i> Linford & Oliveira <i>Longidorus elongatus</i> (deMan) Thorne & Swanger
Lucknow, Uttar Pradesh	Chewing type	<i>Hoplotaimus angustallatus</i> Whitehead <i>Helicotylenchus erythrine</i> (Zimmerman) Golden <i>Tylenchorhynchus nudus</i> Jenkins <i>Ditylenchus (triformis?)</i> Hirschmann and Sasser <i>Longidorus</i> sp. <i>Aphelenchus avenae</i> Bastian

Only young motile females were observed in case of *R. reniformis*.

Besides those mentioned in Table I, some of the nematodes of the non-plant parasitic genera commonly observed in almost all samples were *Dorylaimus*, *Rhabditis* and *Acrobeles*.

This work was done during a short training course on plant nematology conducted in October-November 1963 at the Indian Institute of Sugarcane Research, Lucknow.

KISHAN SINGH.<sup>a</sup>

H. M. SHAH.<sup>b</sup>

G. V. G. KRISHNA MURTY.<sup>c</sup>

G. G. PATEL.<sup>d</sup>

May 4, 1964.

<sup>a</sup> Indian Institute of Sugarcane Research, Lucknow (U.P.).

<sup>b</sup> Institute of Agriculture, Anand (Gujarat).

<sup>c</sup> Tobacco Research Station, Hunsur (Mysore)

<sup>d</sup> College of Agriculture, Junagadh (Gujarat).

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## A SOFT ROT OF STORED ONION BULBS

THE attention of the authors was drawn towards a rot of bulbs of onion stored in the local markets. Occasionally a large percentage of stored material was found to be affected. The disease was observed throughout the year. It was, however, more severe in the months of July, August and September.

The disease first appears as dirty white spots on the outer scales giving a water-soaked appearance to the affected area. Gradually the spots increase in size and the spotted region becomes soft. Finally the whole bulb becomes pulpy. At this stage the rotted bulb can easily be distinguished from a healthy one.

The causal organism was isolated by the usual methods. It grew well on solid *Asthana* and

Hawker's Medium 'A', and showed the following morphological characters.

Septate mycelium; branched hyaline hyphae; sclerotia soft and light brown when young, mature sclerotia olive brown to clove brown, 500  $\mu$  to 800  $\mu$ , globose, hard; cells of sclerotial wall hyaline, globose or polyhedral, 6-8  $\mu$  in diameter.

The fungus has been identified as *Sclerotium rolfsii* Sacc. and it has been confirmed by C.M.I., Kew, Surrey, England. The pathogenicity of the isolate has been confirmed by various inoculation experiments. Under artificial inoculations the symptoms similar to those found in the stored bulbs are produced after 6 to 10 days. Reisolations from these artificially inoculated diseased materials produced cultures identical to the original ones.

This disease of onion has not yet been recorded in India. Recently Thakur *et al.* (1962) have described a rot of stored garlic bulbs by *Sclerotium cepivorum* Berk.

Our grateful thanks are due to Dr. J. C. F. Hopkins of Commonwealth Mycological Institute, Kew, Surrey, England, for his help in identification of the fungus.

Plant Path. Laboratory,  
Botany Department,  
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SUDHIR CHANDRA.

R. N. TANDON.

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## CHAETOMIUM SUCCINEUM AMES —A NEW RECORD TO INDIA

AMONGST the existing species of *Chaetomium* only few are known from India. During the course of his survey of leaf-spot diseases of Allahabad, the author came across a species of *Chaetomium* on leaves of *Cannabis sativa* L. infected by *Colletotrichum glaucosporioides* Penz. The detail morphological studies of the isolate showed it to be *Chaetomium succineum* Ames. A careful survey of the lists of fungi reported from India showed that there was no previous record of this organism from India and thus it is described here as a new record for the country.

Colony on potato dextrose agar dirty white in colour (reverse pale smoke gray), numerous perithecia but not crowded, perithecia globose to ovate, 220-360  $\times$  140-230  $\mu$ , with a ostiole and numerous lateral, slender and septate hairs, affixed to the substratum with slender rhizoids, terminal hairs in the form of a loose cluster (Fig. 1B), amber-coloured, lateral hairs are

3.5–4  $\mu$  in diameter, acuminate or with a blunt apex which is coiled with 1–3 convolutions. Asci clavate, eight-spored (Fig. 1 A),  $35 \times 15 \mu$ , spore part  $27 \mu$ . Mature ascospores pale olive brown, globose to ovate (Fig. 1 A), rounded to subacute at the ends,  $14 \times 7.5 \mu$ .

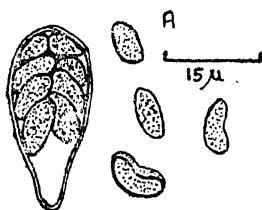


FIG. 1 A

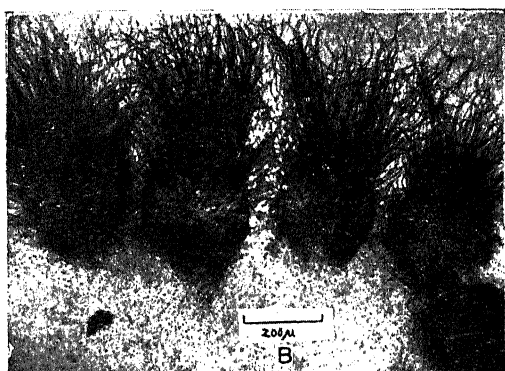


FIG. 1 B

A culture of the isolate has been deposited in the Herbarium of Commonwealth Mycological Institute, Kew, Surrey, England (No. IMI 100455) and culture collection of the Botany Department.

Plant Path. Laboratory, SUDHIR CHANDRA.  
Botany Department,  
University of Allahabad,  
Allahabad, April 24, 1964.

# POSSIBILITIES OF TRANSFERRING HIGH BRANCHING HABIT OF *BRASSICA NIGRA* KOCH. TO *BRASSICA* *JUNCEA* COSS THROUGH AMPHIDIPOIDY

*Rai*, *Brassica juncea* Coss, is generally grown as a mixed crop with wheat or barley and very rarely it is grown as a pure crop. In the existing varieties under cultivation the branching starts at a low level shading the crop with which it is grown mixed and thereby interfering with it. This shading and the consequential reduction in yield of the other crop could be minimized if a variety of *rai* is evolved in which the branching starts at a high level from the

ground. This note outlines the origin of such a variation in artificially synthesised *B. juncea*.

*B. juncea* is an amphidiploid between a 20-chromosome species belonging to the A genome and a 16-chromosome species belonging to the B genome group or *Brassica*.<sup>1-3</sup> There are at least 10 species of *Brassica* having the somatic chromosome number 20 while only one species, *B. nigra* is known in the B genome group having  $2n = 16$  chromosomes. The species in both the groups have many cultigens. If crosses are made between the various cultigens of the A and B genome species we should expect enormous variability in the resulting amphidiploids and their progeny. High branching habit is present in some of the cultigens of *B. nigra*. With the object of transferring this character to *B. juncea* through amphidiploidy, crosses were made between *B. chinensis* L. and *B. nigra* Koch. and the resulting sterile  $F_1$  hybrids were treated with 0.4% aqueous colchicine in glycerine to duplicate their chromosomes. Some of the plants arising from this cross and having  $2n = 36$  chromosomes were found to possess the desired high branching habit (Fig. 1, Plant 2

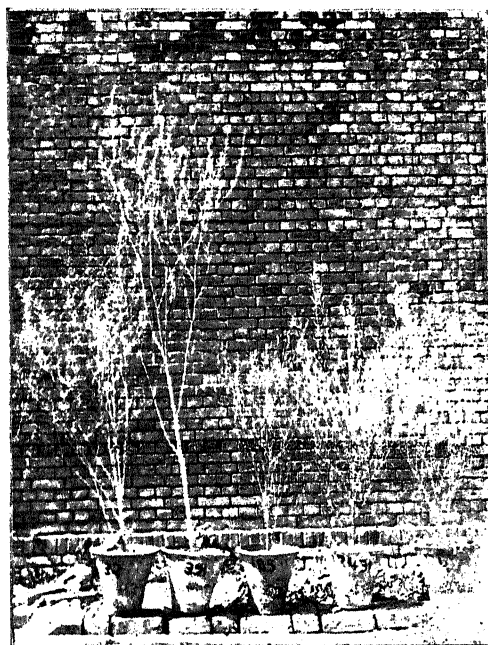


FIG. 1. Transfer of high branching habit to *Brassica juncea* through amphidiploidy. Compare Plant 2 from left with the other normal plants of low branching habit. from left). *B. chinensis* crosses readily with the other species of the A genome group producing more or less fertile hybrids. Therefore, the amphidiploid obtained by crossing *B. chinensis* with *B. nigra* is equivalent to *B. juncea*.

Hence it should cross with the latter making it possible to transfer the high branching habit of the synthesised amphidiploid to natural *B. juncea*. It should also be possible to transfer this character from *B. nigra* to *B. juncea* through amphidiploids derived from *B. campestris* var. *toria*  $\times$  *B. nigra*,<sup>3</sup> *B. campestris* var. *sarson* (yellow and brown seeded)  $\times$  *B. nigra* and *B. rapa*  $\times$  *B. nigra* as true hybrids have been obtained between these species (Srinivasachar, unpublished).

This work was done at the IARI centre of Pirrcom under the ægis of the ICAR to whom my thanks are due. My thanks are also due to Dr. M. S. Swaminathan, Head of the Division of Botany, IARI, New Delhi, for his encouragement.

Regional Research Centre, D. SRINIVASACHAR.  
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#### A NOTE ON THE OCCURRENCE OF *HETERODERA CACTI* (NEMATODA: HETERODERIDAE) FROM MYSORE

DURING the course of collection of plants infested with nematodes, the author came across the cactus plants infested with cyst-forming nematode. Species of *Echinopsis* are grown in horticultural and private gardens especially as rockery plant. On closer examination of the diseased specimens in the laboratory a number of cysts characteristic of cyst-forming nematode, *Heterodera*, were seen. The species was identified as *Heterodera cacti* Filipjev et Sch. Stekhoven, commonly referred to as cactus-cyst nematode. The occurrence of *H. cacti* has not been reported previously from India.

*Heterodera cacti* has a wide host range attacking nearly 30 species of plants belonging to 15 genera. It is chiefly distributed in the European countries of Holland, Italy and Spain. Adam<sup>1</sup> first described in detail the cyst-forming nematode on the plants of *Phyllocactus akkermanii* and *Cereus speciosus* from Holland. He classified the nematode as a strain of *Heterodera schachtii* Schmidt., but later Filipjev and Stekhoven<sup>2</sup> elevated it to the specific level and named it *H. cacti*. Southey<sup>3</sup> made a detailed study of the morphology of the cysts and the vulval cone, and recorded 29 new cactus hosts.

The cysts collected in Bangalore were found to adhere to roots at the collar region of the

plant. The symptoms of the damage caused by *H. cacti* are not observed clearly even when the plant is affected severely. The cysts from the soil have been recovered by using 'floatation technique'.<sup>4</sup> The cysts have a lemon-shaped body (Fig. 1) excluding the neck and the vulval



FIG. 1. Cysts of *Heterodera cacti*, about  $\times 50$ .

cone measuring about 0.5 mm. long and about 0.4 mm. broad at the broadest portion across the body. The colour varied from golden yellow to dark brown. The vulval cone without bullae, the knob-like structure within the vulval cone is absent. The cysts are circumfenestrated, having a circular hatching pore.

The cactus nematode is not so economically important as the cyst-forming species of *Heterodera rostochiensis* Wollenweber or *H. schachtii* Schmidt., on potato and sugar-beet respectively. As the cactus nematode attacks only roots and the collar region of the host plant, the healthy aerial part can be used for vegetative propagation safely and the nematode can be controlled by planting the healthy sets on the non-infested soil.

Grateful acknowledgement is due to Dr. H. C. Govindu for the help and guidance extended to me during the course of this work.

Division of Plant Pathology, A. C. KUMAR.  
Agricultural Research Institute,  
Hebbal, Bangalore-24, May 27, 1964.

- \*1. Adam, W., *Bull. Mus. Hist. nat. Belg.*, 1932, **7**, 1 (*Helm. Abs.*, **1**, p. 201).
- \*2. Filipjev, I. N. and Schuurmans Stekhoven, Jr. J.H., *A Manual of Agricultural Helminthology*, E. J. Brill, 1941, **15**.
3. Southey, J. F., *Nematologica*, 1957, **2**, 1.
4. Goodey, J. B., *Laboratory Methods for Work with Plant and Soil Nematodes*, Her Majesty's Stationary Office, London, 1963, p. 12.

\* Original not seen.

## REVIEWS

Proceedings of the International School of Physics "Enrico Fermi", Varenna, Italy. (Academic Press, Inc., 111, Fifth Avenue, New York-3.)

Course 14: *Ergodic Theories*. Edited by G. Polvani, 1961. Pp. 241. Price \$ 7.50.

The course ran from May 23 to May 31, 1960, and its Director was P. Caldirola. It was attended by forty-two persons. The subject-matter of the course was covered in two sections. The first section consisted of lectures and the following were the speakers: L. Rosenfeld—Questions of irreversibility and ergodicity; C. Truesdell—Ergodic theory in classical statistical mechanics; G. Ludwig—Axiomatic quantum statistics of macroscopic systems (ergodic theory); A. Loinger—A study of the quantum ergodic problem; L. Van Hove—The problem of master equations.

The second section comprised seminars and the following were the speakers: D. L. Falkoff—Master equations and H-theorems; J. L. Lebowitz—Phase-space description of non-uniform systems; U. Uhlhorn—On the mathematical structure of the quantum statistics for time-dependent phenomena; E. G. D. Cohen—Generalization of the Boltzmann equation to higher densities; P. Resibois—Invariants in N-body systems; E. Verboven—On the theory of electron transport. C. V. R.

*The Theory of Transition-Metal Ions*. By J. S. Griffith. (Cambridge University Press, Bentley House, 200, Euston Road, London, N.W. 1.) Pp. x + 455. Price 95 sh. net.

This noteworthy treatise is a unified and deductive introduction to that part of theoretical physics now usually referred to as ligand-field theory. The field of application of that theory is rapidly expanding and in view of this circumstance, the author has thought it more suitable and helpful to concentrate upon the methods of the theory rather than upon the details of applications. Hence, though a considerable survey of experimental measurements appears in the last three chapters of the book, it is by no means exhaustive.

A good part of the volume is devoted to the exposition of the essential prerequisites for a proper understanding of the theory of the physical properties of the ions in compounds.

This will be evident from the following recital of its contents. Chapter 1 is introductory and refers to the following topics: the transition metals and their compounds, stereochemistry, the valencies of transition metals and the theories of chemical binding. Chapter 2 deals with angular momentum and related matters. Chapter 3 considers electromagnetic fields. Chapter 4 discusses the structure of free atoms and ions. Chapter 5 considers the role of magnetic effects in atomic structure. Chapter 6 sets out the theory of groups and their matrix representations. Chapter 7 is concerned with complex ions. Chapter 8 deals with crystal-field theory and the weak-field coupling scheme, while Chapter 9 considers the strong-field coupling scheme. Chapter 10 considers paramagnetic susceptibilities. Chapter 11 is devoted to the optical spectra and thermodynamic properties, while the subject of the Chapter 12 is paramagnetic resonance. Six appendices follow containing tabular matter and mathematical notes. The treatise exhibits a very high standard of scholarship and didactic power. Its printing and get-up is what everyone expects from the Cambridge University Press. The treatise will be welcomed by all concerned with spectroscopy and chemical physics. C. V. R.

*Vapour Pressure of the Elements*. By An. N. Nesmeyanov. (Translated and edited from Russian by J. I. Carasso), (Infosearch Ltd., 207, Brondesbury Park, London, N.W. 2, Distributed by Cleaver-Hume Press, Ltd., 10-15, St. Martin's Street, London, W.C. 2), 1963. Pp. 469.

Experimental values of the saturated vapour pressure are needed in order to calculate heats of sublimation and of evaporation of condensed phases. In the electronic valve industry, in vacuum metallurgy, and in many other branches of science and technology vapour pressure effects are often among the most important.

In the volume under review, the experimental results of many authors are presented in tabular form and as plots of the logarithm of the vapour pressure against reciprocal absolute temperature. From the most reliable data, combined with thermodynamic functions, the coefficients of the equation giving the vapour pressure as a function of temperature were evaluated, for

each element, on a fast electronic computer, and vapour pressure values were computed at fixed temperature intervals. The results are given in the extensive tabulations to be found at the end of the book. These results are preceded by a systematic account of the methods of measuring vapour pressures contained in the first chapter of the book. C. V. R.

**The Physics and Chemistry of Ceramics: Proceedings of a Symposium held at the Pennsylvania State University in May 28-30, 1962.** Edited by Cyrus Klingsberg. (Gordon and Breach, Science Publishers, New York), 1963. Price : Paper bound \$ 9.50 ; Cloth \$ 14.50.

Traditionally, the ceramic industry has been directed towards the production of glass and clay-based products. The first pure oxide ceramic, sinteralumina, paved the way for the expansion of ceramics from its narrow classical basis into the wide field of all inorganic, non-metallic materials. This period of expansion also saw great triumphs of the empirical methods, especially the finding of ferroelectric  $\text{BaTiO}_3$  and that of square-loop ferrites by ceramists. The empirical methods were, however, found to be deficient from the point of view of the reproducibility, the gap between the required and the actual properties, and the reliability of the empirical materials. These deficiencies were especially felt by ceramists working in those fields where very exacting quantitative property requirements were made of the materials necessary, e.g., for electronics, space-exploration, energy conversion uses, etc. The need for a greater understanding of the relationship between structure and properties in order to improve the performance of ceramic materials led the ceramists to seek the help of solid state physics and solid state chemistry, in their efforts to solve problems of ceramics and related ionic solids.

The volume under review comprises the papers presented at the Symposium held in Pennsylvania in May, 1962. The meeting was organized to review the principles of solid state physics and solid state chemistry that are applicable to research and education in ceramics, and to examine mechanisms by which ceramics curricula can be made more responsive to the future needs of materials research.

The following is the list of papers presented at the Symposium: The Interrelation of Ceramics, Metallurgy, Chemistry and Physics by F. Seitz; Ceramic Problems for the Consideration of the Solid State Physicist by W. R.

Bussem; Properties and Crystal Structure of Materials by L. V. Azaroff; Crystal Chemistry in Research on Ionic Solids by R. Roy; Impurity Controlled Properties of Ionic Solids by A. D. Franklin; Transition Metal Ions in Solids by D. S. McClure; The Use of Pressure to Investigate the Electronic Structure of Ionic Crystals by H. G. Drickamer; Diffusion in Ionic Crystals by C. E. Birchenall; The Science and Technology of Sintering by J. E. Burke; Optical Properties of Ionic Crystals by R. J. Maurer; The Chemical Approach to Semiconductors by H. C. Gatos and A. J. Rosenberg; Magnetic Properties of Ceramics by L. R. Bickford, Jr.; The Strength of Ceramic Crystals by J. J. Gilman; Dislocation Theories of the High-Temperature Creep of Crystalline Solids by R. Chang; Effects of Microstructure on the Properties of Ceramics by W. D. Kingery; Recent Developments in Nucleation Theory by G. W. Sears; Federal Sponsorship of Research in Ceramics by C. Klingsberg and The Future of Ceramic Education—A Panel Discussion.

The lively discussions following each paper provide interesting and useful reading. The list of papers will indicate that the volume will be of great help not only to ceramists, but also to the physical scientists engaged in research in inorganic, non-metallic solids but are unaware of the many problems that are as yet unsolved in this field. M. S. SUBRAMANIAN.

**The Periodic Table (Third Edition).** By D. G. Cooper. (Butterworth and Co., 4 and 5 Bell Yard, London, W.C. 2), 1964. Pp. x + 110. Price 10 sh. 6 d.

This pocket-size publication of a little more than a hundred pages will serve as an excellent guide to teachers of inorganic chemistry to pre-university and under-graduate classes in Indian Universities.

The Periodic Table has brought systematization in the teaching of inorganic chemistry. Its importance and usefulness lie not only in its regularities but, probably more so, in its irregularities also. In fact it is the latter, viewed against the theory of atomic structure, that has led to a deeper understanding of the chemical and physical properties of inorganic molecules. The author has laid stress on these points.

The book may be divided into two parts, a first part of about 60 pages dealing with the elements according to the well-known chemical groups I to VIII and 0; and a second part of about 40 pages which gives an account of the

Periodic Table as a whole, followed by separate short sections on a few special topics of interest.

This is the third edition of the book in which extensive revisions have been made and some new material added.

**Experimental Fluid Mechanics.** By P. Bradshaw. (Pergamon Press, London), 1964. Pp. xii + 210. Price 20 sh.

This handy publication is a companion volume to the other books which are of a more theoretical nature, in the series dealing with the analytical side of engineering fluid mechanics. The series as a whole is a planned one published under the ægis of the Thermodynamics and Fluid Mechanics Division of the Commonwealth and International Library of Science, Technology and Engineering. Its aim is to provide suitable guide books which will meet the immediate requirements of the mechanical engineering student in his undergraduate course.

The introductory chapter outlines the necessary elements of theory required, such as use of dimensional analysis, simplification of equations of motion to problems in hand, etc., which will be useful in the experimental chapters to follow. The second chapter is on wind tunnels and test rigs. This is followed by four chapters on techniques of measurement with a final chapter on types of experiments which includes an analysis of six published experiments. Each chapter contains a few selected examples the answers to which are given at the end of the book.

**Survey of Biological Progress (Vol. 4).** Edited by Bently Glass. (Academic Press, New York and London), 1962. Pp. xiii + 465. Price \$ 10.00.

This volume, fourth of this series, offers six quite different, yet in some respects related, views of important new areas in modern biology. The first essay entitled, "Animal Taxonomy and New Systematics" by R. E. Blackwelder, is thought provoking and is sharply critical of trends in the "new systematics". The author brings out a sharp distinction between taxonomy and the study of speciation which is a part of the now dominating field of evolution. The second essay

H. Fraenkel Conrat gives a thorough analysis of properties of infectious nucleic acid, especially of the ribose variety. Most of the conclusions given therein were derived from work on tobacco mosaic virus, and many indications suggest that they are valid for all simple and probably also for the more complex RNA and DNA viruses, possibly for non-viral

DNA or in fact for the germinal substances of all cells. This work already constitutes a modern classic of biology in the new era of genetochemistry. This is followed by C. H. Li's review on "Protein Structure and Biological Activity of the Pituitary Hormones" which is another fascinating chapter of modern molecular biology.

L. E. Brown's essay on "Home Range in Small Mammal Communities" is the fourth essay where the author surveys the old and new methods of study of home range. The fifth essay offers an exhaustive review of the biochemistry of energy transformations in photosynthesis by André T. Jagendorf, and covers some of the most important advances in all of recent biology. The final article in this volume is a chronicle of the magnificent biological achievement within the last three decades: 'the Discovery and Application of Antibiotics'. These reviews are authoritative and clear, and likely to be of great assistance to students and specialists. T. S. SADASIVAN.

**The Theory of the Electronic Spectra of Organic Molecules.** By J. N. Murrell. (Methuen & Co. Ltd., London), 1963. Pp. xiv + 328. Price 55 sh.

Organic chemists, who dextrously use ultra-violet and visible spectra empirically and are keen to learn the underlying theories, owe thanks to Dr. J. N. Murrell for this book. Spectroscopists, dismayed by the type of organic compounds, will find here a systematic presentation of them, the problems that exist and the methods to tackle them.

After an introductory chapter on light absorption, and two chapters dealing with wave functions, valence bond and molecular orbital theories, the author starts with ethylene, the simplest unsaturated molecule, and its isoelectronic systems. Then are treated acetylenes (and isocyanides), polyenes, cyclic polyenes (porphyrins, etc.), the cumulated double-bonded systems (allenes, etc.), and the benzenoid systems—naturally, the longest chapter in the book, where many theories are discussed. Non-alternant hydrocarbons, radicals and ions are postponed to Chapter 12. In considering the weakly interacting chromophores (Chapter 7), a logical approach is given to the splitting of excited states and exciton interactions.

Chapter 8 discusses the spectra of a large variety of organic compounds, the carbonyl group, the  $\beta$ -ketoesters, the nitrogen heterocycles, etc., where transitions of non-bonding

electrons occur. The effect of the inductive, steric and mesomeric effects on spectra are described in three chapters; the dangers inherent in employing the resonance concept to spectroscopic data are lucidly treated with examples. The last two chapters are on organic molecular complexes, and fluorescence and phosphorescence. Five appendices deal with simple quantum mechanical calculations and Appendix 6 gives the useful energy-wavelength table.

The book is liberally illustrated with graphs, formulæ and tables. It is one of the very readable monographs on quantum mechanical approaches to specific issues. G. B.

**The Genetics of the Silkworm.** By Y. Tazima. (Logos Press Ltd. in association with Elek Books Ltd., 14, Great James Street, London, W.C. 1), 1964. Pp. xii + 253. Price 50 sh.

The domesticated silkworm holds a place of great economic importance in certain parts of the world, especially in Japan. This has been particularly made possible by the vast strides taken by her in scientific and technological achievements. While the magnitude of contribution made by Japan has been realised by the world at large from the occasional reviews appearing on scientific aspects, a comprehensive and consolidated account of the work remained hidden in Japanese literature. In the present volume the author, who is a veteran investigator in the field, has been successful in bringing to light a large volume of work conducted on the genetics of the silkworm on fundamental as well as applied aspects.

The volume comprises of eleven chapters and an appendix listing silkworm genes. The first introductory chapter outlines the biology of the silkworm. In the subsequent chapters hereditary traits, linkage maps, developmental genetics, sex determination, cocoon colours, the maternal inheritance, genetic control of hormonal mechanism, mosaicism, parthenogenesis and polyploidy, mutation and radiation mutagenesis have been dealt with. The last two chapters indicate the scope of application of genetical studies in practical sericulture and the future horizons holding promises for fruitful lines of investigation. It has been shown, for example, that polyploidy which is mainly responsible for improved strains in economically useful plants does not result in improved strains of silkworm in the breeds so far used. The separation of males and females at the egg stage is important for industrial sericulture since males yield a larger quantity of silk. The author along with

his collaborators has made possible this separation by radiation induced chromosome translocation.

This comprehensive work is a valuable reference book for active workers in the field and serves admirably as an advanced treatise on the subject.

M. B. SHYAMALA.

#### Books Received

From : (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York-3, N.Y.):

*International Review of Neurobiology* (Vol. 6). Edited by C. C. Pfei, 1964. Pp. xi + 476. Price \$ 15.00.

*Mammalian Protein Metabolism* (Vol. 1). Edited by H. N. Munro and J. B. Allison, 1964. Pp. xv + 566. Price \$ 18.50.

*Comparative Nutrition of Man and Domestic Animals* (Vol. 2). By H. H. Mitchell, 1964. Pp. xxi + 840. Price \$ 20.00.

*Radiation, Isotopes and Bone*. By F. C. Mclean and A. M. Budy, 1964. Pp. xii + 216. Price : Cloth \$ 5.95 ; Paper \$ 3.45.

*International Review of Cytology* (Vol. 16). Edited by G. H. Bourne and J. F. Danielli, 1964. Pp. viii + 345. Price \$ 14.00.

*The Cell—Biochemistry, Physiology, Morphology* (Vol. 6). Edited by Jean Brachet and Alfred E. Mirsky, 1964. Pp. xiv + 564. Price : Regular \$ 18.00 ; Subscription \$ 16.00.

*Experimental Chemotherapy* (Vol. 2). Edited by R. J. Schnitzer and F. Hawking, 1964. Pp. xvii + 614. Price \$ 23.00.

*Advances in Nuclear Science and Technology* (Vol. 2). By E. J. Henley and H. Koutz, 1964. Pp. x + 378. Price \$ 14.00.

*Physiology of Mollusca* (Vol. 1). Edited by K. M. Wilbur and C. M. Yonge, 1964. Pp. xii + 473. Price \$ 16.00.

*Categories of Human Learning*. Edited by A. W. Melton, 1964. Pp. xvi + 356. Price \$ 8.50.

*Medicinal Chemistry* (Vol. 3, No. 1)—*Molecular Pharmacology—The Mode of Action of Biologically Active Compounds*. Edited by E. J. Ariens, 1964. Pp. xviii + 503. Price \$ 17.00.

*Synchytrium*. By J. S. Karling, 1964. Pp. xviii + 470. Price \$ 17.50.

*Cytology and Cell Physiology* (Third Edition). Edited by G. H. Bourne, 1964. Pp. xvii + 780. Price \$ 20.00

*Methods in Cell Physiology* (Vol. 1). Edited by D. M. Prescott, 1964. Pp. xiii + 465. Price \$ 16.50.

*Infra-Red Absorption Spectra Index for 1958-1962*. By H. M. Hershenso, 1964. Pp. xx + 153. Price \$ 12.00.



## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the Ph.D. Degree in Physics to Sri. C. Haranath for his thesis entitled "Studies on dielectric dispersion on certain polar molecules and the spectroscopic determination of relaxation times"; Ph.D. Degree in Nuclear Physics to Sri. M. Visweswara Rao and Sri. A. Seshagiri Rao for their theses entitled "Studies on the radioactive decay and angular correlations with an Electronic Summing Scintillation spectrometer" and "Studies on the total cross-sections of gamma-rays and radioactive decay of some nuclei using a Compton Scintillation spectrometer" respectively; Ph.D. Degree in Zoology to Sri. P. Chandra Mohan for his thesis entitled "Studies on zooplankton of Godavari Estuary".

Osmania University has awarded the Ph.D. Degree in Geology to Sri. C. Leelanandam for his thesis entitled "The charnockites and associated rock types of the Kondapalle area".

### The Indian Pharmaceutical Congress Association

The XVI Session of the Indian Pharmaceutical Congress Association will be held during December 26-28, 1964, at Baroda, Gujarat. Those who intend to attend the Session or submit papers in any of the following sections, viz., Pharmacy, Pharmaceutical and Analytical Chemistry, Pharmacology and Bacteriology, Pharmacognosy and Phytochemistry, Indigenous Pharmacy and Pharmaceutical Education may please write to Dr. Diptish Chakravarty, Hony. Gen. Secretary, The Indian Pharmaceutical Congress Association, 18, Convent Road, Calcutta-14.

### Genus *Bracon* Fabricius (Braconidae: Hymenoptera) Parasitising a Gall-Forming Psyllid (Psyllidae: Homoptera, Hemiptera) on *Ficus glomerata*

Atma Ram and B. R. Subba Rao, Division of Entomology, I.A.R.I., New Delhi, write:

Species of the genus *Bracon* Fabricius have upto now been recorded as ectoparasites of Lepidoptera, Coleoptera and Diptera. No species of the genus *Bracon* has so far been recorded as a parasite of an insect belonging to Hemiptera. The authors reared a large number of a *Bracon* sp. from leaf galls on *Ficus glomerata* at Delhi. Dissections of the galls revealed the presence of

Psyllid, later identified as *Pauropsylla depressa* Crawford (Kindly identified by Dr. R. N. Mathur, Dehra Dun).

This record of a *Bracon* sp. attacking a Psyllid is of interest from 3 points: (1) It is the first record of a *Bracon* sp. attacking a hemipteron host; (2) it is an indication of the rather widely polyphagous habits of the ectoparasitic genus *Bracon* and (3) the 3 orders, viz., Lepidoptera, Coleoptera and Diptera, from which *Bracon* spp. have been so far recorded, all belong to the Endopterygota, whereas this is the first instance of an exopterygotan host being attacked by a *Bracon* sp.

### *Leptosphaerulina trifolii* (Rost) Petrak on *Juszticia gendarussa*—A New Host Record from India

P. K. Daradhiyar, Department of Botany, Ranchi College, Ranchi, writes:

During the studies of mycoflora of Ranchi the author came across a leaf-spot disease of *Juszticia gendarussa* in the month of September 1963, caused by the pathogen *Leptosphaerulina trifolii* (Rost) Petrak, which resembles in all the morphological characters with that reported by H. N. Satya and V. K. Rajlakshmy (*Curr. Sci.*, July 5, 1964) on *Cassia obtusifolia*, *C. tora* and *C. absus* from Bhopal. One very significant point in this case is that in addition to the above-noted pathogen two other pathogens, viz., *Glomerella cingulata* (Stonem) Spauld and Schrenk and *Periconia byssoides* Pers. ex Schew were growing together, which also appear to be new records from India. The specimen has been deposited at C.M.I., Kew, London, England.

### Michelson's Interferometer Used to Measure Infra-Red Spectrum of Night Airglow at High Altitudes

H. P. Gush and H. L. Buijs of the McLennan Laboratory, University of Toronto, have reported their measurements of the spectrum of the night airglow in the region 1.2-2.5  $\mu$ , obtained with a Michelson's interferometer equipped with a cooled lead sulphide detector, carried to altitudes of about 90,000 feet by a balloon. The complete  $\Delta v = 2$  sequence of the rotation-vibration band of OH has been observed at a resolution sufficient to resolve the rotational structure. For the first time, the (0, 0) band of the electronic transition  ${}^1\Delta_g - {}^3\Sigma_g^-$  of oxygen

at  $1.27\mu$ , involving the ground state, has been observed in the night sky spectrum. It cannot be observed at ground level because of the absorption due to atmospheric oxygen.

The interferometer was enclosed in a thermo-statted, shock-proofed styrofoam box, and fine adjustments of the mirrors and necessary alignments were effected by a command receiver in response to signals sent from a ground-based transmitter. The interferometer and other electronic and telemetric facilities were carried in the gondola which was launched at 10-30 p.m. the night of September 20, 1962, from Valcartier, Quebec, and the flight lasted until 4-15 a.m. on September 21.

The following signals were telemetered to ground and were displayed during the entire flight: (a) the main interferogram at three amplifications, (b) the reference interferogram, (c) the interferometer temperature and (d) the scan position. Ten of the interferograms used in measurements were recorded at altitudes in excess of 80,000 feet.—(*Canad. Jour. Phys.*, 1964, 42, 1037.)

#### Plan to Set up a 150-Inch Telescope in Australia to Study the Magellanic Clouds

The Astronomer Royal, Sir Richard Woolley, accompanied by other British astronomers, visited Australia in July for talks with leading members of the Australian Academy of Sciences on the setting up of a 150-inch optical telescope for detailed study of the Magellanic Clouds. Three sites are under consideration: Coonabarabran in New South Wales. Mount Serle, 200 miles north of Adelaide; Mount Singleton near Perth.

The Magellanic Clouds have been described as "a unique laboratory for the study of the birth and evolution of stars". Professor Bart J. Bok of the Australian National University described their importance as follows: "Far to the south of the celestial equator lie two great treasures of astronomy—the twin assemblages of stars known as the Clouds of Magellan. These satellite systems of our galaxy can increase our understanding of the structure and dynamics of galaxies in general. The most luminous super-giant stars are spread out in rich array in the Clouds of Magellan, often surrounded by glowing masses of hydrogen in which new stars are in the process of formation."

The Clouds are only about 180,000 light-years away. They have another major attraction, namely, they are not obscured by the cosmic dust that blocks our view of much of the Milky Way, the star-rich central plane of our galaxy.

The Clouds bear the name of the explorer Ferdinand Magellan whose chronicler mentioned them in his log of 1521 during the first circumnavigation of the world.—(*Australian Science Newsletter*.)

#### Magnetic Field in the Galaxy M 82

A. R. Sandage and W. C. Millar of Mount Wilson and Palomar Observatories have obtained optical evidence for the existence of a large-scale magnetic field in the spiral galaxy designated M 82. Their photographs, made in blue light with the 200-inch telescope, reveal a previously undetected array of filaments extended as far as 13,000 light-years above and below the centre of the disc of M 82. The filaments are believed to be the remnants of a violent explosion that took place at the centre of the galaxy some 1.5 million years ago. Radiowaves from the filaments are characteristic of synchrotron radiation, which is produced by the rapid gyration of high energy electrons in a strong magnetic field. Light from the filaments is highly polarized, with the electric vector of the light waves perpendicular to the filamentary structure. These findings indicate the existence of a more or less uniform large-scale magnetic field directed along the minor axis of M 82.—(*Scientific American*, July 1964.)

#### International Seismological Centre

A research centre which will co-ordinate the work of seismological laboratories throughout the world is to be set up in Edinburgh. Seismological institutes in 30 countries are expected to take part in the centre's work. The centre, to be known as the International Institute of Seismological Research, will provide up-to-date information on the occurrence of earthquakes and give architects and others an accurate picture of the regions where earthquakes occur most frequently.

The Edinburgh centre will be fully automated. Information received from seismological laboratories on punched cards provided by the centre will be processed by computers.—(*British Information Services*.)

# THE NEW PHYSIOLOGY OF VISION

## Chapter I. Introductory

SIR C. V. RAMAN

THE faculty of vision plays an immensely important role in human life and activity. There are three different aspects of that faculty, viz., the perception of form and space, the perception of luminosity and the perception of colour. Each of these categories of perception is operative over a wide range of variation of the effects perceived. Very remarkable, also, is the degree of precision and capacity for discrimination exhibited in each case. A fuller understanding of these features of our visual perceptions is obviously of the highest interest and importance.

The beliefs currently entertained regarding the matters referred to above have been largely inherited from the era of scientific advance when it was thought that the wave-theory of light was the proper foundation for an understanding of the phenomena of vision. To find a way out of the difficulties then arising, certain hypotheses and assumptions were introduced and adopted as articles of faith, thereby inhibiting an unbiased study of the facts which would have revealed their inadmissibility. Physiological optics thus became a species of make-believe, instead of real knowledge based on reason and experiment.

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On the 2nd of October 1959, the author gave at his Institute in Bangalore a lecture on "Light, Colour and Vision" which was an exposition of the outstanding features in the functioning of the visual organs of man. The lecture as actually delivered traversed only familiar ground, but the study of the subject undertaken at the time made it evident that great lacunæ existed in our understanding of the facts of visual optics. The author was thereby encouraged to enter the field with a view to develop the subject on new lines.

The first steps in the direction indicated were taken in the author's address to the Annual Meeting of the Indian Academy of Sciences in December 1959, which was published in *Current Science* for January 1960. The title of the address was "The Sensations of Colour and the Nature of the Visual Mechanism" and it sought to interpret the known facts of colour perception and colour discrimination on the basis of a new concept of the functioning of the human retina, viz., that it receives the energy quanta of the incident light and transforms them into electri-

cal impulses which travel along the optic pathways and reach the cerebral centres.

\* \* \* \*

Soon afterwards, the author devised a simple but highly effective method by which an observer can view his own retina in the act of functioning, in other words, perceive the response of the retina when light of any chosen spectral composition is incident on it. The method reveals that the foveal region of the retina differs greatly from the areas surrounding it in respect of the sensitivity to different parts of the visible spectrum.

In Memoir No. 125 of the Raman Research Institute entitled "The Perception of Light and Colour and the Physiology of Vision" published in December 1960, this method of studying the retina was described in detail and its results were illustrated by a few pictures of the retina in colour as thus observed. It was shown that by using colour filters which isolate particular regions of the spectrum for illuminating the retina, the method enables the spectroscopic behaviour of the absorbing pigments present in the retina to be determined and the manner in which they are distributed over its area to be ascertained.

The use of polarised light in conjunction with colour filters and the same technique enabled further progress to be made. It was shown that the absorbing material present in the retina which is effective in the blue region of the spectrum and enables it to be perceived is a carotenoid pigment having elongated molecules. In the foveal region of the retina, these molecules set themselves radially along the nerve fibres in that region. The well-known fact that the unaided eye can detect polarised light was thus shown to be a consequence of the molecular form and absorptive properties of the visual pigment which is effective in the blue region of the spectrum. Memoir No. 133 of the Raman Research Institute entitled "The Role of the Retina in Vision" published in August 1962 discusses these findings and includes more pictures of the retina in colour.

\* \* \* \*

Early in the year 1963, the author commenced a systematic study of the immense array of material available for the study of colour in the shape of the flowers and foliage of the plant world. The aim was to determine by factual

observations the relation which actually exists between the perceived colour and the spectral composition of the light reflected by or transmitted through the petals of flowers or the leaves of plants. Quite simple methods, viz., visual observation of the light through a pocket spectro-scope provided with a wavelength scale enabled numerous samples to be quickly examined. The results of such observation were checked and confirmed by photographic registration of the spectra and a critical study of the record.

The results of the first few months of work on these lines were described and illustrated in Memoir No. 137 of the Raman Research Institute entitled "Floral Colours and the Physiology of Vision" which was published in August 1963. The results were extremely striking and they led to some significant conclusions regarding the colour sensations excited by polychromatic radiation. Later work with more material confirmed the results and conclusions set out in the memoir. Studies of a similar nature were also undertaken with natural and synthetic gemstones, textiles and technical products of various sorts exhibiting colour. The results in every case supported the conclusions reached by the study of floral colours.

The outcome of the investigations was to establish the fundamental thesis that the primary physiological sensations are those excited by monochromatic radiation and to show that the sensations excited by polychromatic radiation are not determinable by simple additive laws. The so-called trichromatic hypothesis and the ideas regarding colour synthesis based on it were found to be definitely contradicted by various facts of observation. One of the most striking facts emerging from the study is the extraordinarily important role played in colour synthesis by the relatively narrow region of wavelengths comprised in the yellow sector of the spectrum. Its presence or absence makes all the difference in the perceived colour of polychromatic radiation.

\* \* \* \*

Under the title "Fluctuations of Luminosity in Visual Fields", the author described in the issue of *Current Science* dated the 5th of February 1964, a phenomenon of extraordinary interest discovered by him. Detailed studies subsequently made confirmed the explanation of it suggested in that preliminary communication. Briefly stated, the substance of the discovery was that a uniformly illuminated screen which diffuses the light falling on it exhibits localised fluctuations of luminosity over its entire area when viewed at some distance from it.

The magnitude and character of the observed fluctuations are found to depend on the strength and spectral character of the illumination and especially also on the distance from which the screen is viewed.

It has been shown that these effects arise by reason of the corpuscular nature and behaviour of light. It is significant that they are observed over a wide range of illumination of the screen, which may be far above the absolute threshold at which the eye ceases to perceive light. Further studies have established that these fluctuations of luminosity stand in the closest relationship to the subject of visual acuity and that they explain the well-known dependance of the visibility of the details of an object on the strength of its illumination and the distance of the object from the observer. Indeed, the variations in the visibility of detail are found to be direct consequences of the local fluctuations of luminosity in the field in which the object is located.

\* \* \* \*

In an article published in the issue of *Current Science* dated the 20th of May 1964 under the title "Stars, Nebulae and the Physiology of Vision", the author discussed the explanation of various familiar facts of experience regarding the objects appearing in the night-sky and our ability to perceive them and observe their characteristics. The article sought to find answers to various questions arising in that connection and especially the following. Why are we unable with our unaided vision to perceive stars fainter than the sixth magnitude? Why do the great majority of stars appear to us merely as specks of light without any hint of colour? Why do gaseous nebulae appear as mere patches of light in small telescopes while as seen through giant telescopes they appear as blazing masses of colour? It was shown in the article that highly significant conclusions regarding the functioning of the visual organs emerge when these questions are examined in the light of the available data regarding the luminosities and spectral characters of the stars and the nebulae.

\* \* \* \*

The foregoing is intended to convey some idea of the vistas of research in the physiology of vision which have been opened by the work of the author since October 1959 when his active interest in this field had its commencement. The account given above does not however attempt to state or even to summarise the results of that work. That is reserved for the succeeding chapters of this work.

## CHANGES IN THE ZONAL CIRCULATION OVER INDIA ACCOMPANYING THE ONSET AND WITHDRAWAL OF THE SOUTHWEST MONSOON

R. ANANTHAKRISHNAN AND A. R. RAMAKRISHNAN

*India Meteorological Department, Poona*

### 1. INTRODUCTION

IN an earlier contribution to this journal (R. Ananthakrishnan and A. Krishnan, 1962) the seasonal variations of the mean monthly contour heights and mean monthly upper winds at four radio-sonde/rawin stations across India were discussed in relation to the southwest monsoon. The stations in question (Trivandrum, Madras, Nagpur and New Delhi) lie approximately along the meridian of  $77^{\circ} 30' \text{E.}$  and cover the latitude belt from  $8^{\circ} 30' \text{N}$  to  $28^{\circ} 30' \text{N}$ . Attention was drawn to a number of interesting features particularly to the reversal of pressure gradients in the upper troposphere that occurs by about the middle of May heralding the onset of the monsoon and the changes in the opposite direction that occur in September-October leading to the retreat of the monsoon. In this contribution we wish to focus attention on the upper wind changes that occur at these four stations in association with the onset and retreat of the southwest monsoon. For this purpose we have made a study of the daily zonal (east-west) and meridional (north-south) components of the upper winds at the four stations during 1963. The results in respect of the zonal components will be briefly considered here.

### 2. THE SOUTHWEST MONSOON OF 1963

Diagrams showing the normal dates of onset/withdrawal of the south-west monsoon over/ from the different parts of the country have been given in the earlier communication. According to the official records of the India Meteorological Department the year 1963 was characterised by the normal onset, withdrawal and activity of the south-west monsoon. The monsoon set in over the south Bay of Bengal during the last week of May and over the extreme south of the Peninsula by 31 May. It advanced into the different parts of the country by about the normal dates and covered the entire country by 17 July. The monsoon began to withdraw from northwest India from 18 September and had retreated from north-west India, Uttar Pradesh, north Madhya Pradesh and Gujarat State by the end of September. By 18 October the monsoon had withdrawn further from north-east India and

the north peninsula and was confined to the south peninsula. A depression which formed over the south-east Bay of Bengal on 18 October and intensified into a cyclonic storm during its westward movement crossed the Coromandel Coast near Cuddalore on the 21st. Later it weakened into a depression and recurving north-eastwards emerged into the Bay of Bengal near Gopulpur on the 26th. Then it rapidly intensified into a cyclonic storm, moved across Burma coast near Akyab and weakened by 28 October.

### 3. UPPER AIR CIRCULATION : ZONAL

3.1. Figures 1-4 represent isopleths of daily zonal upper winds from the surface to heights varying from 18 to 24 km. for the stations Trivandrum, Madras, Nagpur and New Delhi based on 1,200 Z rawin observations. Each figure depicts the zonal winds for the following two epochs :

(a) April-May-June ;

(b) August-September-October (in respect of New Delhi the period chosen is July-August-September for reasons which will be explained below).

The upper set of charts in each of the figures illustrate the changes in the zonal circulation in association with the onset of the south-west monsoon in 1963 ; the lower set of charts illustrate the corresponding changes accompanying the retreat of the monsoon. The main features brought out by these diagrams are briefly discussed below.

### 3.2. Circulation during April-May-June

April.—Although April is a summer month the atmospheric circulation over India in this month corresponds generally to the pattern prevailing in the earlier winter months. Over Trivandrum and Madras the zonal flow is predominantly easterly in the lower troposphere up to 4-5 km. with speeds less than 20 knots. In the upper troposphere, moderate to strong westerlies are noticed. At 18/21 km., however, the flow appears to be easterly with comparatively weak winds. Over Nagpur and New Delhi the flow is westerly at all levels up to 18 km. Between 18 and 24 km. winds are extremely weak and appear to be generally easterly. In the lowest 1 km. over Trivandrum the flow is westerly due to sea breeze whereas over Madras

on the east coast, the sea breeze which is from the east is merged in the lower troposphere with height attaining maximum speed at nearly 12 km. Above this level there is rapid weakening of wind with height. The strength of the westerlies over the peninsula as well as the westerlies in the entire troposphere to the north are characterised by rapid increase in speed with height attaining maximum speed at nearly 12 km. Above this level there is rapid weakening of wind with height. The strength of the westerlies increases from south to north, the

## ZONAL WINDS - TRIVANDRUM 1963

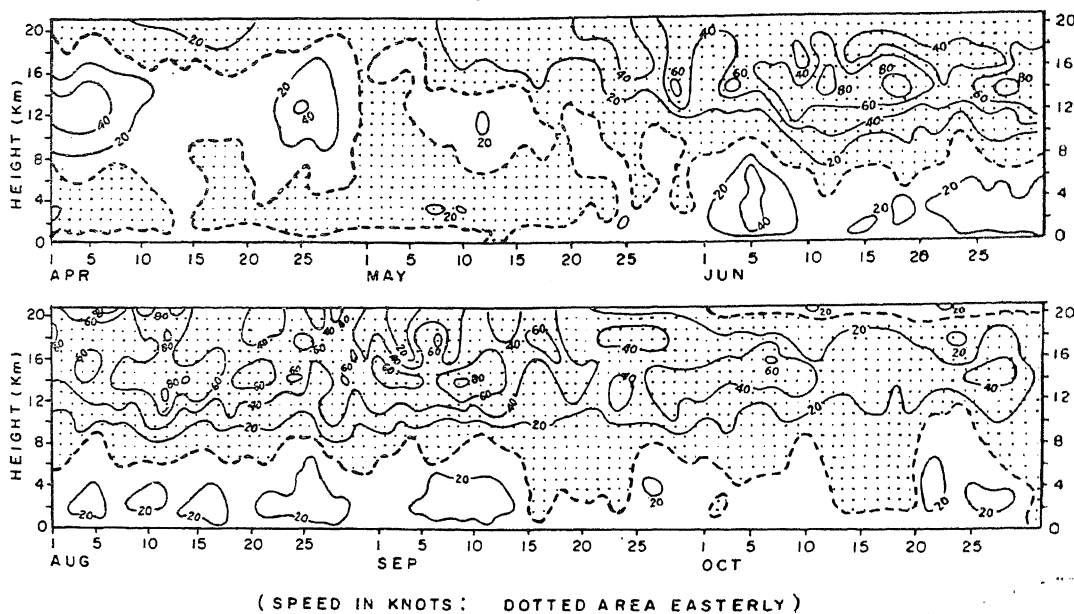


FIG. 1

## ZONAL WINDS - MADRAS 1963

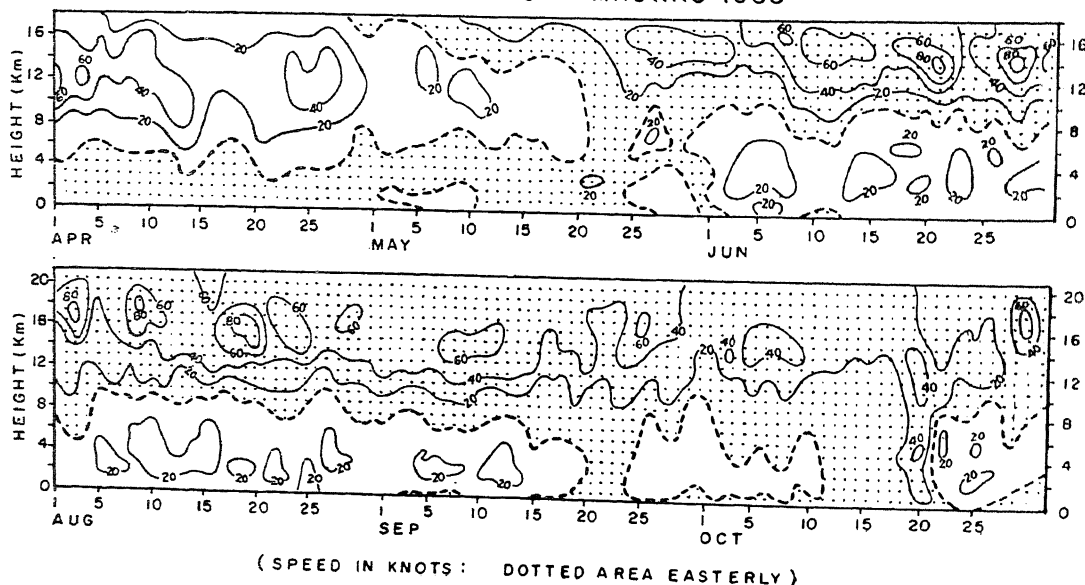


FIG. 2

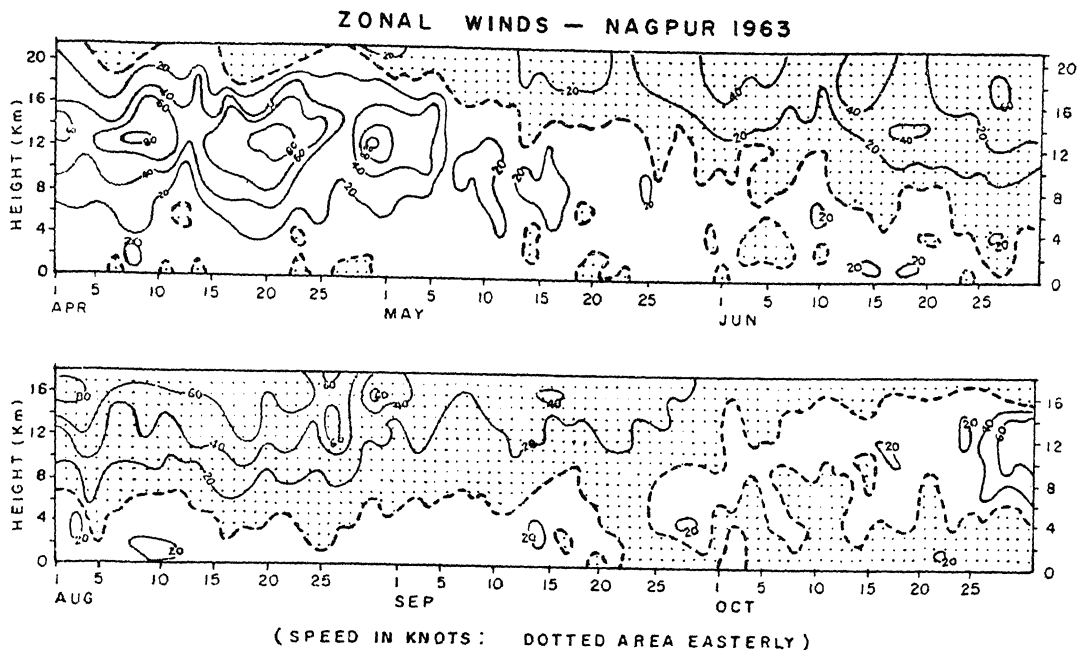
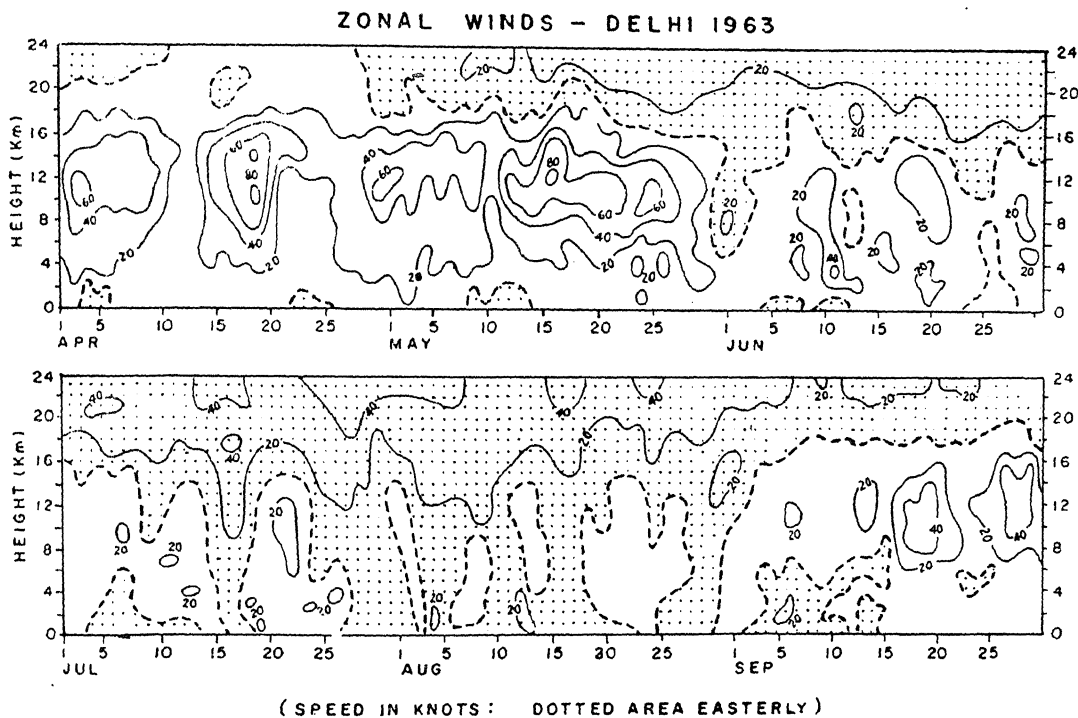


FIG. 3



maximum speeds over Trivandrum being slightly above 40 knots, over Madras 50/60 knots, over Nagpur 80/90 knots and over New Delhi 70/80 knots. Thus the strongest westerlies in the upper troposphere are noticed over Nagpur. The flow is not uniformly strong but there are definite spells of maximum winds lasting for 7 to 10 days.

*May.*—A marked change in the circulation occurs over Trivandrum from the beginning of May. The lower tropospheric easterlies extend upwards and the upper tropospheric-lower stratospheric easterlies reach downwards with the result the westerlies in between these two become shallow in depth and weaken. From about 20th the high level easterlies show signs of strengthening and the next ten days witness large fluctuations in the zonal flow pattern. This breaking up and readjustment are noticed over Madras also. Marked changes in the flow also occur over Nagpur and Delhi. The high level easterlies over the stations progressively descend to lower levels especially over Nagpur. An abrupt weakening of the westerlies at 12 km. takes place by 6th of May over Nagpur, and by 30th of May over Delhi. The first sign of strengthening (speed exceeding 40 knots) of the upper tropospheric-lower stratospheric easterlies over Nagpur is seen on the last day of the month.

*June.*—Commencing from the last day of May and throughout June the zonal flow over Trivandrum is characterised by steady westerlies in the lower levels up to 7-8 km. and easterlies aloft. Two spells of strong westerlies lasting 8-10 days are noticed towards the beginning and towards the end of the month. The upper easterlies increase in speed rapidly with height reaching maximum values at 14 km. At this level the speed is more than 60 knots continuously with higher speeds of 70/90 knots occurring in short spells of 2-3 days. Between 16 and 18 km., the easterlies are comparatively weaker but higher up speeds again increase. The flow over Madras is similar except that the lower westerlies extend to slightly higher levels of 8-9 km. The level of maximum speeds in the upper easterlies is also somewhat higher. Over Nagpur the lower tropospheric westerlies are interspersed with short spells of easterlies. The upper tropospheric easterlies gain in strength and from about the 20th—the approximate date of extension of the monsoon over Nagpur—and thereafter easterlies exceeding 40 knots blow continuously. The flow is westerly up to about 14 km. over Delhi with easterlies aloft. The field is generally weak, the speeds rarely exceeding 20/30 knots and showing considerable fluctuations.

### 3.3. Circulation during August-September October

*August.*—The zonal flow patterns over Trivandrum and Madras in August are similar to those discussed for June and indicate continuance of the features associated with sway of the southwest monsoon. The flow over Nagpur in August is also similar to that of June; the lower westerlies and upper easterlies are, however, more steady and organised.

*September.*—The lower tropospheric westerlies over Trivandrum and Madras weaken appreciably from the middle of this month; from about the same time the upper easterlies too commence weakening. From 15 September the flow is much weaker at all levels over Nagpur; the pattern is breaking up during the last week of the month.

*October.*—Over Trivandrum and Madras progressive reduction in the strength of both the lower westerlies and the higher easterlies noticed in September continues and by the 1st of the month easterlies prevail throughout the troposphere. The spurt of westerlies in the lower levels and strengthening of easterlies at high levels seen during the last ten days of September occurred in association with the formation and movement of the cyclonic storm referred to in Section 2. At 21 km. over Trivandrum the field appears to be westerly while at Madras the available observations indicate that the easterly regime still continues. Over Nagpur the breaking up and reversal of the circulation pattern seen in the last week of September is complete by the first of October and from this date onwards westerlies prevail in the upper troposphere with easterlies below. The westerlies gather speed from 26th reach about 40/50 knots by the end of the month. At 18 km. weak easterlies are seen throughout the month.

### 3.4. Circulation over Delhi during July-August-September

The onset of the monsoon over the Delhi area takes place normally by the beginning of July and the retreat by the middle of September. Hence the wind circulation for the period July-August-September has been considered over Delhi. The diagrams indicate that up to 15 km. in the months of July and August the flow consists of alternate spells of westerlies and easterlies of varying durations with speeds rarely exceeding 20 knots. Above this level easterlies with speeds 25/35 knots prevail throughout the period with occasional spells of 40/50 knots between 18 and 24 km. From the beginning of September the westerly regime



characteristic of winter circulation gains predominance and by the 15th of this month the westerlies dominate the entire troposphere from the surface to 18 km. Strong spells of westerlies of 45/55 knots between 9 and 14 km. are already noticed in the second half of September. Between 18 and 24 km. the circulation is easterly with speeds 15/30 knots.

#### 4. CONCLUSIONS

This preliminary study of the zonal flow over India along a meridian (roughly 78° E.) based on a year's data (1963) brings out the following features relating to changes in the circulation accompanying the onset and withdrawal of the southwest monsoon over India :

(i) While the circulation pattern in April is characteristic of winter conditions, the beginning of May witnesses initiation of changes in this pattern which are completed by end of this month leading to the establishment of the monsoon circulation. Over the peninsula these changes are the reversal of the winter circulation with easterlies below and westerlies aloft into the monsoon circulation with westerlies below and easterlies aloft. Over the central parts of the country the winter westerly regime of the middle and upper troposphere is replaced by easterly regime. Over north India this reversal is most conspicuous in the upper troposphere/lower stratosphere.

(ii) The commencement of the pattern of strong westerlies below and strong easterlies aloft at Trivandrum and Madras; the strengthening of upper tropospheric/lower stratospheric easterlies over Nagpur; and the abrupt weakening of the strong upper tropospheric westerlies over Delhi occurred almost simultaneously within a period of two to three days at the end of May 1963.

(iii) The changes accompanying the withdrawal of the monsoon are fairly sudden over Delhi but gradual over the southern stations. Strong westerlies at 12 km. characteristic of winter circulation are noticed at Delhi abruptly from 16th September. The reversal of lower westerly and upper easterly circulation is seen over Nagpur near the end of September. The cessation of the lower westerlies and the strong upper tropospheric easterlies typical of the southwest monsoon, takes place over Madras and Trivandrum by the end of October.

We are making a comprehensive study of various aspects of the general circulation over India and neighbourhood based on upper wind data for the period 1957-1964. Further results of our studies will be presented in future communications.

1. Ananthakrishnan, R. and Krishnan, A., *Curr. Sci.* 1962, 31, 133.

### ORIGIN OF THE HYPERSTHENE METEORITES

IN a recent symposium on meteorites conducted by the National Academy of Sciences, E. Anders of the University of Chicago reported that since the year 1800 more than 600 meteorites have been seen to fall and have then been recovered. An examination of these meteorites revealed that 93% of them are stony rather than metallic, and that more than half are chondrites that contain chondrules, or finer grains, of the mineral hypersthene. Isotope dating indicates that many meteorites underwent rapid cooling somewhat 4 billion years ago. The hypersthene meteorites, however, have in common a much later cooling date, namely, 400 million years ago only.

One way of accounting for this fact would be to assume that all the hypersthene chondrites

were fragments of a single asteroid that was involved in a catastrophic collision at the late date, namely, 400 million years ago. Searching for astronomical evidence to support this hypothesis Anders noted that four swarms of small asteroids, comprising more than 34 individuals, are not tidily in orbit between Jupiter and Mars. Instead they follow unusually long paths that bring them inside the orbit of Mars. Pointing out that such eccentric travellers would be "ideal launching pads" for earthbound debris, Anders suggests that each of the four swarms represents the shattered remnants of a larger body and that one of the four is the source of all hypersthene chondrites.—(*Scientific American*, July 1964.)

## HYPERSONIC FLOW PAST A WEDGE

GIRISHWAR NATH\*

Thököly út 82, Budapest XIV, Hungary

## NOTATION

 $a = [(dp/d\rho)_s]^{1/2}$ , velocity of sound. $\rho$  = density. $T$  = absolute temperature. $R, \theta$  = polar co-ordinates. $u, v$  = velocity components. $\alpha$  = semi-vertical angle of the wedge. $\psi$  = shock wave angle. $p$  = pressure. $h$  = specific enthalpy. $q$  = free-stream velocity. $m$  = free-stream Mach number. $\gamma$  = ratio of specific heats. $u_0$  = value of  $u$  on the surface of the wedge. $q_{\max.}$  = maximum value of  $q$  corresponding to zero pressure. $C_p$  = pressure coefficient.

## SUBSCRIPT

1, 2 denote conditions ahead of the shock and just behind it respectively.

 $\alpha, \psi$  and  $\theta$  denote values on the surface of the wedge, on the shock wave and at an angle  $\theta$  in the shock layer.

## 1. INTRODUCTION

The hypersonic flow past a wedge at zero angle of incidence was first considered by Meyer.<sup>1</sup> He exhibited the solution by means of curves showing the relationships between the pressure, speed and angle of the wedge. His equations were reproduced by Ackeret,<sup>2</sup> who added a photograph of the flow in the neighbourhood of a wedge showing that Meyer's regime does in fact occur. The solution has certain limitations which are obvious from an inspection of Meyer's curves. These limitations have been

treated independently and in greater detail by Bourquard.<sup>3</sup> In the present paper closed form solution of the above problem has been obtained and the various flow characteristics have been expressed in terms of two independent variables,  $m$  and  $\alpha$ . The minimum value of  $m$  and the maximum value of  $\psi$ , for which the shock is detached from the surface of the wedge, the minimum value of  $\psi$ , for a given  $\alpha$ , and the maximum value of  $\alpha$ , beyond which no solution is possible, have been obtained.

## 2. BASIC EQUATIONS AND SOLUTION

Consider an inviscid hypersonic flow over a wedge at zero angle of incidence. If the angle of the wedge is less than a certain value, an attached shock wave springs from the vertex. Now all the flow properties will depend upon  $\theta$ . It is assumed that viscosity is zero and there exists thermodynamic equilibrium. The equation governing the flow characteristics in the shock layer is given by

$$\frac{d^2 u}{d\theta^2} + u = 0. \quad (1)$$

The boundary conditions are:

$$u = u_0, \quad \theta = \alpha; \quad v = du/d\theta = 0, \quad \theta = \alpha.$$

Hence

$$\frac{u}{q_{\max.}} = \frac{m \left( \frac{2}{\gamma-1} + m^2 \right)^{\frac{1}{2}} \cos \psi}{\cos (\psi - \alpha)} \cos (\theta - \alpha) \quad (2)$$

$$\frac{v}{q_{\max.}} = \frac{m \left( \frac{2}{\gamma-1} + m^2 \right)^{\frac{1}{2}} \cos \psi}{\cos (\psi - \alpha)} \sin (\theta - \alpha) \quad (3)$$

(the direction of  $v$  is negative).

From (2) and (3),

$$u^2 + v^2 = \lambda^2 \quad (4)$$

where

$$\lambda = \frac{m}{\left( \frac{2}{\gamma-1} + m^2 \right)^{\frac{1}{2}}} \frac{\cos \psi}{\cos (\psi - \alpha)} q_{\max.}$$

\* Permanent address: Lecturer in Mathematics, Science College, Patna University, Patna 5 (Bihar), India.

Equation (4) represents a circle whose radius is  $\lambda$ . From oblique shock relations and equations (2) and (3) we have

$$m^2 = \operatorname{cosec} \psi \left[ \frac{2 \cos (\psi - \alpha)}{\sin (2\psi - \alpha) - \gamma \sin \alpha} \right]. \quad (5)$$

From equation (5),  $\psi$  can be obtained if  $m$  and  $\alpha$  are known.

## 2.1. Velocity, Mach Number and Velocity of Sound in the Shock Layer

The velocity, etc., are given by:

$$\frac{q_\theta}{q_{\max.}} = \frac{m}{\left( \frac{2}{\gamma - 1} + m^2 \right)^{\frac{1}{2}}} \frac{\cos \psi}{\cos (\psi - \alpha)} \quad (6)$$

$$\frac{q_\theta^2}{\gamma} = \frac{1}{2} q_{\max.}^2 \left[ 1 - \frac{m^2 \left( \frac{2}{\gamma - 1} + m^2 \right)^{-1} \cos^2 \psi}{\cos^2 (\psi - \alpha)} \right] \quad (7)$$

$$m_\theta^2 = \frac{2}{\gamma} \frac{\left\{ m^2 \left( \frac{2}{\gamma - 1} + m^2 \right)^{-1} \cos^2 \psi \right\} / \cos^2 (\psi - \alpha)}{1 - \left[ \left\{ m^2 \left( \frac{2}{\gamma - 1} + m^2 \right)^{-1} \cos^2 \psi \right\} / \cos^2 (\psi - \alpha) \right]} \quad (8)$$

## 2.4. Minimum Value of $m$ and Maximum Value of $\psi$

From equation (5), the minimum value of  $m$  and the maximum value of  $\psi$ , for which the shock wave is detached from the wedge, can also be calculated. The results of sections 2.3 and 2.4 are given in Table I.

TABLE I  
 $\gamma = 1.405$

$\alpha$	Minimum value of $\psi$	Maximum value of $\psi$ , for which the shock is detached	Minimum value of $m$ , for which the shock is detached
10°	12° 3.5'	67°	1.4221
20°	24° 21.5'	65°	1.8430
30°	37° 18.5'	66°	2.5348
40°	52° 18'	66°	4.5210

## 3. NUMERICAL CALCULATION AND DISCUSSION

To illustrate the method, the complete calculation is given in Table II.

The proximity of the shock to the surface of the wedge increases as  $m$  increases. The temperature, pressure and density increase as  $m$  or  $\alpha$  or both increase.  $m$  suddenly decreases at the shock, the decrease being more rapid for higher values of  $m$  and  $\alpha$ . It can be seen from Table II that the flow becomes subsonic when  $\alpha = 40^\circ$ .

## 4. CONCLUSIONS

As compared with cones, wedges produce more disturbance in the flow. For equal cone and wedge angles, the surface pressure rise and the shock angle are greater for wedges. Thus a wedge of given angle is a more sensitive instrument than a cone for determining the Mach number of a stream by measuring the Mach angle or pressure rise, but on the other hand, cones of larger angle than wedges may be used with a given Mach number. The shock wave is in contact with the leading edge of the wedge at higher speeds than it does in the case of the cone of the same angle.

The pressure coefficient

$$C_p = \frac{2}{\gamma m^2} \left[ \frac{2\gamma m^2 \sin^2 \psi - (\gamma - 1)}{\gamma + 1} - 1 \right]. \quad (9)$$

The pressure gradient on the surface of the wedge is zero, i.e.,

$$(\partial C_p / \partial \theta)_{\theta = \alpha} = 0.$$

## 2.3. Minimum Value of $\psi$ and Maximum Value of $\alpha$

From equation (5), the minimum value of  $\psi$ , for a given  $\alpha$ , is determined by  $\sin(2\psi - \alpha) - \gamma \sin \alpha = 0$ . The maximum value of  $\alpha$ , beyond which no solution is possible, is given by  $\sin \alpha = 1/\gamma$ . For  $\gamma = 1.405$ ,  $\alpha$  is  $45^\circ 50.5'$ .

TABLE II

$\alpha$	10°	10°	10°	20°	20°	20°
$m$	23.146	16.742	11.277	15.564	11.452	9.58
$\psi$	12.5°	13°	14°	25°	25.5°	26°
$\frac{p_a}{p_1} = \frac{p_\psi}{p_1}$	29.1552	16.4026	8.5268	50.3729	28.2316	20.12
$\frac{\rho_a}{\rho_1} = \frac{\rho_\psi}{\rho_1}$	4.969	4.4047	3.569	5.555	4.938	4.64
$\frac{T_a}{T_1} = \frac{T_\psi}{T_1}$	5.867	3.7238	2.389	9.068	5.717	4.40
$C_{pa}$	0.07746	0.07820	0.0842	0.2901	0.2955	0.30
$\frac{q_a}{q_{\max}} = \frac{q_\psi}{q_{\max}}$	0.9721	0.966	0.953	0.9005	0.8930	0.88
$\frac{Q_a}{Q} = \frac{Q_\psi}{Q}$	0.9772	0.975	0.972	0.9097	0.9097	0.9
$m_a$	4.9445	4.4554	3.7526	2.4079	2.3671	2.21

$\alpha$	30°	30°	30°	40°	40°	40°
$m$	26.562	13.827	10.491	27.764	15.302	11.73
$\psi$	37.5°	38°	38.5°	52.5°	53°	53.5°
$\frac{p_a}{p_1} = \frac{p_\psi}{p_1}$	305.3316	84.498	49.663	566.673	174.328	104.73
$\frac{\rho_a}{\rho_1} = \frac{\rho_\psi}{\rho_1}$	5.8289	5.569	5.3104	5.892	5.753	5.63
$\frac{T_a}{T_1} = \frac{T_\psi}{T_1}$	52.382	15.1729	9.352	96.179	30.302	18.60
$C_{pa}$	0.6138	0.6216	0.6292	1.0012	1.0536	1.00
$\frac{q_a}{q_{\max}} = \frac{q_\psi}{q_{\max}}$	0.797	0.7846	0.7739	0.6216	0.6112	0.60
$\frac{Q_a}{Q} = \frac{Q_\psi}{Q}$	0.8002	0.795	0.7913	0.6235	0.6180	0.6
$m_a$	1.5738	1.5094	1.4461	0.9462	0.9198	0.84

## 5. SUMMARY

A closed form solution to the inviscid hypersonic flow past a wedge, at zero angle of incidence, with an attached shock has been obtained. Viscosity, heat transfer, dissociation, etc., are not taken into account. The different flow characteristics have been expressed in terms of  $\alpha$  and  $m$ .

1. Meyer, R. E., *Mit. Forsch. Arb. Ingenieurw.*, 1908, No. 62.
2. Ackeret, J., "Gas dynamik," *Handbuch der* 1927, 7, Chap. 5.
3. Bourquard, *Mémor. Artill. française*, 1932, 1
4. Hayes, W. D. and Probstein, R. F., *Hy Flow Theory*, Academic Press, New York, p. 139.

## LETTERS TO THE EDITOR

### PROPAGATION OF ULTRASONIC WAVES IN PLASMAS

THE interaction of ultrasonic waves with a plasma has been investigated by Surdin<sup>1</sup> and a dispersion relation for an isothermal plasma is obtained. A similar relation for the case in non-isothermal plasmas has been given by Bhatnagar<sup>2</sup> who has also suggested a method of determining ion and electron temperatures in a plasma.

Both investigations relate to the case in which the atomic number of the ion is equal to unity. In this note, the results are extended for any ionic charge ( $Z$ ) and the modified results are presented.

Using the same notation employed by Bhatnagar, the exact dispersion relation that takes note of ( $Z$ ) will be

$$\frac{1}{\gamma k T_e} (\omega^2 - \omega_p^2) V^4 + \left[ \frac{\omega_p^2}{M} \left( \frac{T_i + Z T_e}{T_e} \right) - \left\{ \frac{1}{m} + \left( \frac{T_i + Z T_e}{T_e} \right) \frac{1}{M} \right\} \omega^2 \right] V^2 + \frac{\gamma k T_i}{m M} \omega^2 = 0.$$

The phase velocities for the cases (1) when  $\omega \ll \omega_p$  and (2) when  $\omega \simeq \omega_p$  are respectively as follows:

$$V_i = \sqrt{\frac{(T_i + Z T_e) \gamma k}{M}}$$

and

$$V_p = \sqrt{\frac{\gamma k T_i}{M}}.$$

If the velocity of propagation of the ultrasonic wave in an unionized gas is denoted by  $V$ , where

$$V = \sqrt{\frac{\gamma k T}{M}},$$

then

$$\frac{T_i}{T} = \left( \frac{V_p}{V} \right)^2; \quad \frac{T_e}{T} = \frac{V_i^2 - V_p^2}{Z V^2}.$$

In terms of the ultrasonic reflection coefficients  $R_i$  at low frequency ( $\omega \ll \omega_p$ ) and  $R_p$  (when  $\omega \approx \omega_p$ )

where

$$R_i = \left| \frac{V_i - V}{V_i + V} \right|^2 \quad R_p = \left| \frac{V_p - V}{V_p + V} \right|^2$$

we can write

$$\frac{T_i}{T} = \left\{ \frac{1 + \sqrt{R_p}}{1 - \sqrt{R_p}} \right\}^2$$

and

$$\frac{T_e}{T} = \frac{1}{Z} \left[ \left\{ \frac{1 + \sqrt{R_i}}{1 - \sqrt{R_i}} \right\}^2 - \left\{ \frac{1 + \sqrt{R_p}}{1 - \sqrt{R_p}} \right\}^2 \right].$$

We note that the electron temperature is inversely proportional to the electric charge of the ion.

The author's thanks are due to Dr. K. S. Viswanathan for his guidance and to the Officer-on-Special Duty, National Aeronautical Laboratory, Bangalore, for kind permission to publish this note.

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### POLYETHYLMETHACRYLATE IN DILUTE SOLUTION

CONFIGURATIONAL and frictional properties of monodisperse polyethylmethacrylate (PEM) in  $\Theta$  (methylethylketone and isopropanol 1:7 by vol.) as well as "good" solvent (methylethylketone) have been studied by S. N. Chinal and co-workers<sup>1</sup> by light-scattering and viscosity techniques. It is felt that extension of range of ideal as well as non-ideal solvents for mono- as well as poly-disperse PEM might lead to interesting conclusions. As a first step we have used ethylacetate as a good solvent for the polydisperse PEM at  $35^\circ \pm 0.01^\circ \text{C}$ .

PEM has been prepared by thermal catalysed (Azobisisobutyronitrile) polymerization of ethylmethacrylate at  $35-70^\circ \text{C}$ . in nitrogen atmosphere with restricted conversion of the latter to ca.  $< 20\%$ . Intrinsic viscosities  $[\eta]$ , of purified and unfractionated PEM in ethylacetate were measured in Ubbelohde type PCL viscometer ( $[\eta] < 300$ ) or in specially designed variable shear rate suspended level dilution viscometer ( $[\eta] > 300$ ). The scattered light intensities by carefully centrifuged and filtered solutions of PEM at  $45-135^\circ$  angles and the refractive index increments (for the incident unpolarized light

$\lambda = 4356 \text{ \AA}$ ) were measured in Brice-Phoenix photometer and differential refractometer respectively. The light-scattering results were treated according to Zimm<sup>2</sup> for determination of weight average molecular weights,  $\bar{M}_w$  ( $7 \times 10^5$  to  $117 \times 10^5$ ), as well as Z average rms end to end distance  $(\bar{r}^2)_z^{1/2}$  (Fig. 1).

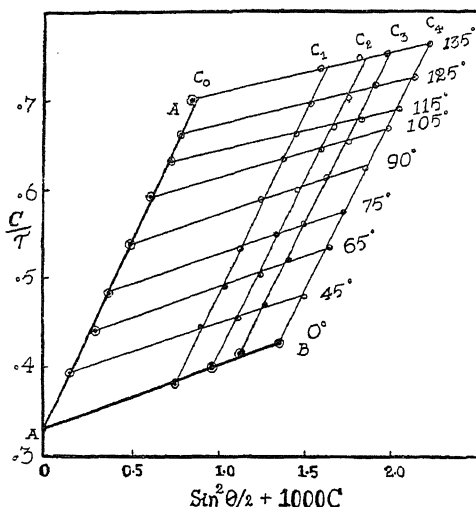


FIG. 1. Zimm Plot.

$C_1, C_2, C_3, C_4$  = Concentration of polymer solution in gm. ml.<sup>-1</sup>,  $\times 1,000$ .

$A'A = (C/\tau)_{\theta=0}$ , Vs.  $\sin^2 \theta/2$ .

$A'B = (C/\tau)_{\theta=0}$  Vs.  $1,000C$ .

$\tau$  = turbidity.

We report the following results: (i) From the intercepts of plots of  $\eta_{sp}/C$  Vs.  $C$  ( $C = 0.002$ – $0.0005$  gm. ml.<sup>-1</sup>) for various samples,  $[\eta]$  (120 to 970 ml. gm.<sup>-1</sup>) were evaluated. Values of Huggin's constants  $k'$  ranged from 0.25 to 0.27.

(ii) From log-log  $[\eta]$  Vs.  $\bar{M}_w$  plots the relationship  $[\eta]_{50^\circ} = 9.03 \times 10^{-2} \bar{M}_w^{0.7057}$  has been established. (iii) The linear nature of Zimm plot (A'A in Fig. 1) and also determination of

number average molecular weights ( $\bar{M}_n$ ) of the polymers by Osmometry has indicated that  $\bar{M}_w/\bar{M}_n \approx 2$  and therefore molecular weight distribution is of exponential type. (iv) The second virial coefficients  $A_2$  (from slope of A'B in Fig. 1) obey a relationship,  $A_2 \propto \bar{M}_w^{-0.24}$ . Values of solvent-polymer interaction constants  $\mu$ , from  $A_2$ , are 0.47 to 0.48. (v)  $(\bar{r}^2)_z^{1/2}$  converted to  $(\bar{r}^2)_w^{1/2}$  (weight average rms end to end distance) according to a recent treatment<sup>3</sup> and

the relationship  $(\bar{r}^2)_w^{1/2} = 0.45 \bar{M}_w^{0.5635}$  has been obtained. (vi) The degree of extension of PEM in ethylacetate  $(\bar{r}^2)_w^{1/2}/(\bar{r}^2)_z^{1/2}$ , has been found to vary from 3.7 to 4.6 for the range of molecular weights studied,  $(\bar{r}^2)_z^{1/2}$ , representing the theoretical rms end to end distance. The apparent discrepancy in these values in ethylacetate and in methylethylketone<sup>1</sup> (2.6 to 3.0) for higher molecular weights would vanish if heterogeneity of the polymers<sup>3</sup> is taken into account.

(vii) From the intercept of the plot  $[\eta]^{2/3}/\bar{M}_w^{1/3}$

Vs.  $\bar{M}_w/[\eta]$ , Flory's constant  $K_\theta = 5.2 \times 10^{-2}$  has been evaluated, the reported<sup>1</sup> value of  $K_\theta$  for homogeneous PEM being  $4.7 \times 10^{-2}$ . (viii) Flory's universal parameter  $\phi$  evaluated from

$[\eta] \bar{M}_w / (\bar{r}^2)_w^{3/2}$  after correction for heterogeneity is  $3.03 \times 10^{23}$  in accord with  $2.9 \times 10^{23}$  reported<sup>1</sup> for homogeneous conditions. (ix) From the slope of the plot  $(\bar{r}^2)_w^{1/2}$  (calculated from  $K_\theta$  and  $\phi$ ) Vs.  $(2P)^{1/2}$  ( $P$  = degree of polymerization) the value of length of the statistical chain element,  $b = 4.08 \text{ \AA}$ , may be compared with the reported value  $4.21 \text{ \AA}$ .

We conclude that (a) the light-scattering data for PEM have been treated in our work by the superior method due to Zimm,<sup>2</sup> (b) the values of parameters  $K_\theta$ ,  $k'$ ,  $\mu$ , etc., as expected do not deviate much from the theoretical values in spite of the PEM being polydisperse and (c) ethylacetate is thermodynamically a poorer solvent than methylethylketone for PEM.

A detailed paper with our experimental results and discussion will appear elsewhere.

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#### A PRELIMINARY THIN-LAYER CHROMATOGRAPHIC STUDY OF THE SEED EXTRACTS OF *GARCINIA KOLA* HECKEL (GUTTIFERAE)

*Garcinia kola* (Bitter kola) is a tree indigenous to Nigeria. Various parts of it have found application in local medicine, and the bitter seeds are useful in bronchitis, etc. (Irvine, 1961; Oliver 1960). No alkaloids have been detected in the seeds, but it is suggested that the active principles reside in the resinous fraction

(Irvine, Oliver). Since little is known of the active principles, this work has been undertaken in order to further elucidate them.

The starchy seeds were decorticated, bruised and extracted with ether at room temperature in order to remove the resin. The residue was macerated overnight in cold water, and the resulting yellow solution filtered and treated with solution of lead acetate to precipitate the non-glycosidal impurities. After filtering, hydrogen sulphide was passed through the solution to remove excess lead. The solution was finally filtered, concentrated and used for chromatography.

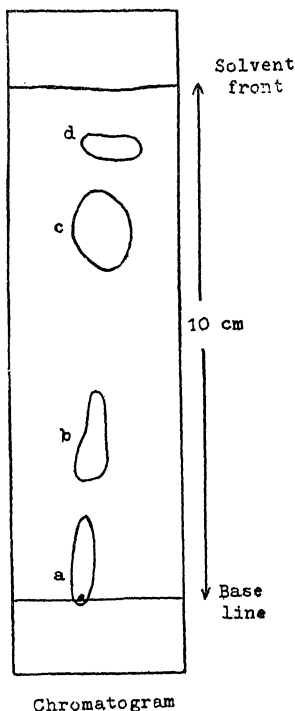


FIG. 1

The above yellow ethereal solution was evaporated to yield a resinous substance which soon turned purplish-brown in colour.

Chromatography of the purified aqueous extract was carried out at room temperature (25° C.). The adsorbent was silica gel G (Merck for T.L.C.) of thickness 250  $\mu$ . The solvent system was methanol/water: 21/1, and average development time, 30 minutes. The spots were detected by the blue fluorescence given by them under an ultra-violet lamp.

The purified aqueous extract of the seeds gave four components, a, b, c and d, on the

chromatogram, three of which (b, c and d) had Rf values of 0.31, 0.74 and 0.90 respectively. The remaining component (a) did not migrate.

The aqueous solution was found to be bitter but the resinous extract tasteless. Thus the bitter principles are water-soluble, but ethereal insoluble. It is therefore likely that the active principles (which are probably glycosides) are not in the resin, but may be constituted by one or more of the water-soluble components separated on the chromatogram.

The purplish-brown colour assumed by the dry ethereal extract seems to be due to a substance which when exposed to the air for some time changes to a purplish-brown colour. The ethereal solution itself retained its yellow colour. The surfaces of some of the decorticated seeds exhibited this colour, especially when the test was originally cracked. The substance giving this colour is slightly soluble in water and was therefore present in the crude aqueous extract. It was, however, removed during the purification of the aqueous extract. The purplish-brown colour is produced either in aqueous or ethereal solution by the addition of a few drops of 10% alcoholic solution of ferric chloride.

The author is grateful to the Research Committee of the University of Nigeria for making funds available in aid of this work.

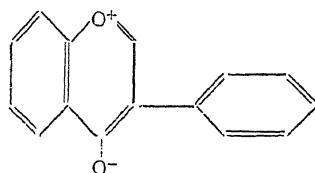
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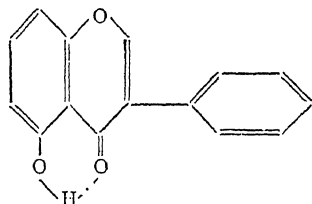
## INFRA-RED SPECTRA OF ISOFLAVONES

In a recent paper<sup>1</sup> Guillardmod and Piguet have recorded that the I.R. absorption of the carbonyl group of isoflavones lies in the region 1620  $\text{cm}^{-1}$  and the frequency rises to 1650  $\text{cm}^{-1}$  if there is a hydroxyl group in the 5-position. We wish to point out that a similar observation was made in our earlier paper on the isoflavonoids of *Ougenia dalbergioides*. In that study, the I.R. spectra of several isoflavonones and related isoflavones<sup>2</sup> were compared (see Table I). An isoflavonone with a free hydroxyl group at the 5-position, the carbonyl absorption is in the 1630-1645  $\text{cm}^{-1}$  region. When the chelate effect of the 5-hydroxyl group is removed by methylation the carbonyl frequency goes up to 1660-1670  $\text{cm}^{-1}$  which is normal to expect for flavone derivatives the effect is just the reverse.

the isoflavones with free 5-hydroxyl exhibit a carbonyl frequency at about  $1660\text{ cm}^{-1}$  and when that hydroxyl group is methylated the frequency instead of rising is lowered to  $1640\text{ cm}^{-1}$ . This special feature was attributed to the predominant resonance structure (A) in isoflavone changing to (B) when a 5-OH group is present. In a later publication Briggs and Cebalo<sup>3</sup> have recorded the carbonyl frequencies of a number of isoflavones in which similar behaviour has been observed.



(A)



(B)

TABLE I

Isoflavones	
	C=O frequency in $\text{cm}^{-1}(\text{KBr})$
1. 5 : 7 : 2' : 4'-(OH) <sub>4</sub> -(dallbergioidin)	1637
2. 5 : 7 : 2' : 4'-(OCH <sub>3</sub> ) <sub>4</sub> ..	1663
	(in CHCl <sub>3</sub> )
3. 5-Hydroxy-7 : 2' : 4'-(OC <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> ..	1614
4. 5 : 7-Dihydroxy-2' : 4'-(OCH <sub>3</sub> ) <sub>2</sub> ..	1643
5. 5 : 2' : 4'-(OH) <sub>3</sub> -7-(OC <sub>2</sub> H <sub>5</sub> )-6-(CH <sub>3</sub> )- (Ougeinin)	1627
6. 5-Acetoxy-2' : 4' : 7-(OCH <sub>3</sub> ) <sub>3</sub> -6-(CH <sub>3</sub> )	1602
Isoflavones	
1. 5 : 7 : 2' : 4'-(OCH <sub>3</sub> ) <sub>4</sub> ..	1640
2. 5 : 7 : 2' : 4'-(OH) <sub>4</sub> ..	1656
3. 5-(OH)-7 : 2' : 4'-(OC <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> ..	1659
4. 5-(OH)-7 : 2' : 4'-(O <sup>+</sup> H <sub>3</sub> ) <sub>3</sub> -6(CH <sub>3</sub> )	1656
5. 5-(OH)-6 : 7 : 2' : 5'-(OCH <sub>3</sub> ) <sub>4</sub> ..	1667 <sup>3</sup>
6. 2'-Benzyloxy-7-(OH)-5 : 8 : 5' (OCH <sub>3</sub> ) <sub>3</sub>	1645 <sup>3</sup>
7. 2' : 7 : 5'-Trybenzyloxy-8 : 5'- (OCH <sub>3</sub> ) <sub>2</sub>	1645 <sup>3</sup>

Flavone derivatives also exhibit similar behaviour as noted earlier by Hergert and Kurth.<sup>4</sup> The validity of structure A is supported by comparison with the I.R. spectra of the analogous structures found in flavylum salts.<sup>5</sup> They have marked absorption in the same region (Table II). The introduction of the group in flavones and isoflavones ..... the pyrylium type ring structure

of A changing it to B and the frequency that is thereby obtained corresponds to the aromatic ketone in which the C=O frequency is diminished by hydrogen bond formation.

TABLE II

Flavylum salts	$\gamma_{\text{Max}}$
1. Apigeninidin chloride	.. 1639-40
2. Luteolinidin chloride	.. 1639-40
3. Tetramethyl luteolinidin chloride	.. 1634-35
4. Pelargonidin chloride	.. 1637 $\pm$ 2 <sup>5</sup>
5. Cyanidin chloride	.. 1639-40
6. Peonidin chloride	.. 1637 $\pm$ 2 <sup>5</sup>
7. Malvidin chloride	.. 1637 $\pm$ 2 <sup>5</sup>

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## SEPARATION OF 1-METHYL-4 AND 5-CYANOMETHYL IMIDAZOLES

A BRIEF review of the methods of preparing N-methyl-4- and 5-substituted imidazole derivatives indicates that there are two types of methods in the literature. In one 4(5) imidazole derivatives are methylated by the usual methods and the two isomers so obtained are separated through fractional crystallisation of their picrates, e.g.,

(i) Methylation of 4(5)-imidazolyl formaldehyde by dimethyl sulphate which yielded only 1-methyl-4-imidazolyl formaldehyde (yield, 5.7%) (Hubball and Pyman, 1928).

(ii) Methylation of 4(5)-hydroxymethyl imidazole by methyl iodide which led to both 1-methyl-4-hydroxymethyl imidazole (in 46% yield) and 1-methyl-5-hydroxymethyl imidazole (in 13% yield) (Rouff and Scott, 1950).

(iii) Methylation of 4(5)-cyanomethyl imidazole by dimethyl sulphate in aqueous sodium hydroxide giving 1-methyl-4-cyanomethyl-imidazole (in 4.3% yield) and 1-methyl-5-cyanomethyl imidazole (in 15% yield) (Pyman, 1911).

In the second type of preparation the individual compounds, 1-methyl-4- and 5-substituted



imidazole derivatives are synthesized by a direct and unambiguous method. In this category those of Jones (1949) for preparing 1:5 substituted imidazoles and Dodson and Ross (1950) for preparing 1:4 substituted imidazoles are worth noting. The method of Dodson and Ross is however only partially unambiguous because although they report the formation of only one form (1:4), they expected a mixture of both 1:4 and 1:5 substituted derivatives.

The above survey thus suggests that if both 1:4 and 1:5 substituted derivatives are required, N-methylation of imidazole compound followed by separation of the mixture of isomers through fractional crystallization of their picrates (in poor yields—*vide supra*) will have to be undertaken and this is apparently a laborious and wasteful procedure. Now when either of the two isomers alone is required one has to employ the method of Jones (1949) or Dodson and Ross (1950). It was here the authors thought of applying a direct chromatographic separation to the N-methylated products for obtaining the two isomers in good yield. Starting from these separated components it would then be possible to prepare any derivative of either 1:4 or 1:5 substituted imidazole.

In order to achieve this, 4(5)-hydroxymethyl imidazole as picrate was prepared according to Horning (1955) and was then converted into 4(5)-chloromethyl imidazole-hydrochloride (Mehler, Tabor and Bauer, 1952). This was then changed into 4(5)-cyanomethyl-imidazole by the action of pot. cyanide and finally into a mixture of two isomers (1:4 and 1:5) using dimethyl sulphate and sodium hydroxide (Pyman, 1911). Using benzene as solvent this mixture of isomers was run over a column of alumina (adsorbent) and was then eluted with a mixture of benzene and ethanol in the ratio 99:1. This gave a clean separation of the isomers with about 40% yield of each component. The compound obtained from the first few fractions collected was identified as 1-methyl-4-cyanomethyl imidazole by preparing its picrate and then comparing it with an authentic sample obtained by Pyman's method (m.p. observed = 202–04° C., reported = 209–10° C. corrected—Pyman, 1911. Mixed m.p. = 203–04° C.). The subsequent fractions collected gave 1-methyl-5-cyanomethyl imidazole, characterised again by its picrate, m.p. 152–55° C. (Reported m.p. 156–57° C. —corrected—Pyman, 1911). Mixed m.p. with an authentic sample was found to be 154–56° C.

It is apparent therefore that the method of chromatographic separation possesses an advantage

over Pyman's method and may be applied to all the isomeric mixtures of 1:4 and 1:5 substituted imidazole derivatives.

The authors express their sincere thanks to Professor G. B. Singh for providing the necessary facilities.

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#### ON THE OCCURRENCE OF A PORPHYRITIC NORITE NEAR MELUR, TRICHUR DISTRICT, KERALA

In his Presidential Address to the Fiftieth Indian Science Congress on the Hypersthene-bearing Rocks of the Madras State, India,<sup>1</sup> P. R. J. Naidu has drawn attention to the occurrence of certain noritic dykes in the Mettupalaiyam area with perfectly porphyritic euhedral (8-sided) crystals of hypersthene, set in a matrix of plagioclase laths which have distinctly intruded into the Peninsular gneisses.

Some six years ago, a rock of an exactly similar description was observed by the present author near the village of Melur (10° 17' 48": 76° 21' 16") in the course of a radiometric survey of parts of the Trichur District of Kerala State (Survey of India sheet No. 58B/7) occupied mainly by the Peninsular gneisses, basic intermediate and acid charnockites. A brief account of its field relationships, petrographic characters and origin is presented in this paper.

From a study of sections in quarries it is seen that the porphyritic norite occurs as vein-like offshoots of a huge lenticular mass of basic granulite occurring in a gneissic formation. The norite vein shows a clear porphyritic texture with euhedral crystals of hypersthene set in a matrix of clear and non-perthitic plagioclase laths. The plagioclase has an anorthite content of 40 to 50% and is twinned according to the Carlsbad and Albite-Carlsbad laws. The basic rock has a granulitic texture, exhibiting a mosaic of equigranular clino and

orthopyroxenes and plagioclase. The plagioclase has an anorthite content of 55 to 70% and is twinned on the Pericline and Albite laws. The rock has a specific gravity of 3.11.

From a study of the mineralogical characters of these two rocks, the author is led to the inference that the porphyritic norite is undoubtedly igneous in origin and is a differentiate of the basic granulite. For example, there is a gradual decrease in the anorthite content of the plagioclase from the basic granulite (An% 55-70) to the porphyritic norite (An% 40-50). Moreover, different fractions of the two rocks show a variation in the relative proportion of the pyroxenes to plagioclase. These features are very characteristic of a differentiated series.

During the radiometric survey of an area of over 100 sq. miles in the Trichur district, the author also made the following significant observations:—

1. The relative amount of charnockites occurring in the area is very minor when compared with the bulk of the gneisses present.
2. The basic charnockites of the area are very restricted in bulk when compared with the acid charnockites which form the bulkiest member.

Large tracts of the Kerala State where charnockites occur are yet to be mapped in detail. When this is done, the author has no doubt that more evidences would be forthcoming in support of P. R. J. Naidu's conviction that there is nothing like a rock called "charnockite", which is not a hypersthene-granite, that there is nothing like an igneous consanguineous series of rocks called the "charnockite-series", which have differentiated from the ultrabasic to the acidic end, and that there is nothing like a province, called "the charnockitic province", which is not at once a granite-gneiss-schist province.

The author is grateful to Prof. D. N. Wadia for kindly permitting publication of this paper, and to Mr. K. K. Dar for his encouragement.

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## ON THE OCCURRENCE OF *DICROIDIUM* FLORA IN SIDHI DISTRICT, MADHYA PRADESH\*

THE note records for the first time an interesting occurrence of a carbonised *Dicroidium* flora from the Sidhi District, Madhya Pradesh, which suggests the presence of hitherto unknown Triassic horizon in the Gondwana succession of the area.

The earliest collections of fossil plants from Sidhi District were made by Hughes<sup>1</sup> in 18 from Bajbai (24° 4' : 81° 57'), Chanduik (24° 6' 30" : 81° 37' 50") and Parasi (24° 2 32° 7'). From these collections Feistmant described *Glossopteris communis*, *G. indi*, *G. angustifolia*, *G. formosa*, *Schizoneura gondwanensis* and *Vertebraria indica* and assigned a Raniganj age to the beds. Later, Ahmad mapped the area in 1952-53 and reported *Schizoneura* sp., *Glossopteris retifera*, *G. indi*, *Vertebraria indica* and *Sphenopteris polymorpha* (Ahmad and Rao<sup>4</sup>). Tripathi<sup>5</sup> identified a vertebrate fossil collected from Marhwas (24° 30" : 81° 47') by Ahmad and Rao as *Rhinesuchus wadaii* and confirmed the late Permian age of the beds.

The present author while engaged in a search for vertebrate fossils near Marhwa Sidhi District, also made a collection of plant fossils from a number of localities. The beds along the Sehra nala, Sondia and Mujga streams contain the already reported forms, such as *Glossopteris indica*, *G. browniana*, *Schizoneura gondwanensis*, *Vertebraria indica* and *Sphenopteris* sp. A very interesting plant assemblage, however, was discovered along the Gopad river near the village Nidpur (24° 7' : 81° 54') in which the plants are exceptionally well preserved as carbonized remains and are thus ideally suited for epidermal studies. In this collection three distinct species of *Dicroidium* could be identified by their epidermal structure. A few fragments of *Glossopteris* were also observed. In addition, the sediments have yielded, in maceration, an assemblage of spores and pollen along with numerous pieces of cuticles.

The discovery of *Dicroidium* in these beds is significant as it reveals, for the first time, the presence of a definite Triassic horizon in the Gondwana succession of Sidhi District. Although lithological demarcation of the horizons is somewhat difficult it may be safely contended that *Dicroidium*-bearing beds of the Gopad river section are certainly not older than the Panchhat. The common occurrence and variety of *Dicroidium* in the beds are, in fact, suggestive of

somewhat younger age comparable with that of the Parsora beds (Lele<sup>6</sup>). A systematic search for plant fossils in this area should certainly prove rewarding in revealing the Palaeozoic-Mesozoic succession of the Gondwanas. The exceptionally well-preserved plants and the presence of spores and pollen have indeed opened a new scope for the detailed study of the *Dicroidium* flora in India.

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Central Palaeontological Laboratories,  
Geological Survey of India,  
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P. P. SATSANGI.

\* Published with the kind permission of the Director-General, Geological Survey of India.

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# EFFECT OF THIOUREA ON SPAWNING IN THE SKIPPER FROG *RANA* *CYANOPHLYCTIS* (Schn).

ALTHOUGH the thyroid gland plays an important role in amphibian metamorphosis,<sup>1</sup> its function in the adult, particularly during reproduction, is still obscure. In almost all animals the thyroid gland is active during breeding season.<sup>2,3</sup> Thyroidectomy or administration of thiouracil, an antithyroid drug, inhibits ovulation in rodents.<sup>4</sup> Whether this action of thyroid is mediated through other endocrine glands is not clear. As the amphibian ovary affords a suitable material to elucidate this problem,<sup>5</sup> a detailed investigation on the activity of the thyroid and the action of antithyroid drugs, particularly thiourea, during reproduction was undertaken. The present investigation describes the effect of thiourea on spawning in the skipper frog.

Unlike other frogs, the skipper frog is gravid throughout the year<sup>6</sup> and is, therefore, selected for experimentation. Gravid frogs weighing 20 to 35 gm., collected in the vicinity of Mysore, were kept in aerated aquaria at a temperature ranging from 20 to 25° C. and were fed orally with minced frog's thigh muscles. Graded doses of thiourea (Atlas Chemicals) ranging from

0.625 µg. to 5 µg. in 1 ml. of distilled water was injected intraperitoneally on alternate days till 9th day. The controls received 1 ml. of distilled water. The spawning response was tested by injecting 4 homoplastic homogenized pituitaries in 1 ml. of distilled water on the 10th day and the number of eggs spawned per frog was counted on the next day. The frogs were autopsied without anaesthesia: The ovary, oviduct, liver, kidney, pituitary and thyroid were dissected out, fixed in Bouin's fluid, sectioned at 7 and 10 µ thick and stained in Ehrlich's hæmatoxylin-eosin and Mallory's triple stains. Except pituitary and thyroid, the rest of the organs were weighed to the nearest mg. The spawning index was calculated as follows:

Spawning index = No. of eggs spawned/frog  
+ % No. of frogs spawned (Incidence) × 10<sup>-1</sup>.

Administration of thiourea has definitely inhibited the rate of spawning. With 1.25, 2.5 or 5 µg. of thiourea there is reduction in the spawning rate by 73.46, 83.41 or 92.51% respectively which is highly significant when compared to that of the controls ( $P < 0.001$ ). But the % incidence of spawning is slightly affected. Almost all thiourea-treated frogs have spawned but the number of eggs released is much reduced depending on the dosage of thiourea. Therefore the spawning index gives a reliable method of evaluating the spawning response. With gradual increase in the dose of thiourea there is proportionate reduction in the spawning index (Table I). The ovaries of the thiourea-treated frogs do not show any discernible changes either in the structure or in the weight when compared to those of the controls. On the contrary the ovaries of the controls are slightly heavier in spite of profuse spawning. It appears, therefore, that thiourea inhibits the release of eggs from the gravid ovary. It is interesting to note that the thyroid gland of the frogs treated with thiourea shows hypothyroidic changes wherein there is spreading of the thyroid follicles lined by thin squamous epithelium. There is no appreciable change in the weights of oviduct, liver and kidney by this treatment. But the per cent loss of body weight and the percentage mortality are higher with higher dose of thiourea.

Whether thiourea acts directly on the ovary making insensitive to gonadotrophins to ovulate or its action is mediated through thyroid, pituitary or adrenals is not clear. No doubt the process of ovulation and spawning in fishes and amphibia is due to the consummate effect

TABLE I  
Effect of graded doses of thiourea on spawning in the skipper frog

Dose μg./frog	% Mortality	% Loss in B.W.	Spawning			Weight (gm.)/100 gm. (B.W. M ± S.E.)			
			No. of egg per Frog M ± S. E.	% Incidence	Index	Ovary	Oviduct	Kidney	Liver
Control (16)	..	12.54	226 ± 8.72	100	32.6	7.02 ± 0.19	1.17 ± 0.19	0.34 ± 0.02	2.56 ± 0.16
6.625 ( 5)	..	7.21	145.6* ± 24.35	100	24.56	4.01 ± 1.14	0.83 ± 0.25	0.25 ± 0.02	1.21 ± 0.08
1.25 ( 8)	..	11.97	60.5† ± 8.73	100	16.05	5.93 ± 1.12	0.95 ± 0.12	0.26 ± 0.01	2.25 ± 0.04
2.5 (12)	16.04	16.04	37.5† ± 8.73	90	12.75	6.96 ± 0.87	1.69 ± 0.33	0.29 ± 0.01	2.35 ± 0.13
5.0 (20)	45.00	16.62	17.08† ± 4.56	75	9.21	6.83 ± 0.81	1.51 ± 0.21	0.35 ± 0.03	2.77 ± 0.3

Number in parenthesis = number of frogs, M ± S.E. = Arithmetic mean ± Standard error.  
Probability (P) = \* = < .01; † = < .001. B.W. = Body weight.

of all endocrine organs, particularly pituitary and adrenals.<sup>6-8</sup> As thiourea is a proved anti-thyroid drug interfering with the synthesis of thyroxine,<sup>9</sup> the antioviulatory action of thiourea is probably mediated through thyroid. Thyroid deficiency in a few species of mammals interferes with the reproductive cycle in the female.<sup>3,4</sup> Thyroidectomy or administration of thiouracil inhibits ovulation in rabbits and mice.<sup>4</sup> It is reported that hypothyroidism reduces the production and release of gonadotrophic hormones of the pituitary, impairs the adrenal function and influences the ovarian response to the gonadotrophins in rats.<sup>10</sup> In this experiment treatment of thiourea induces hypothyroidism which in turn may affect the spawning response directly or indirectly through the pituitary and adrenals. However this experiment is subjected to criticism because of the possibility of toxicity exerted independently of the effect on thyroid hormone production. Investigations are being conducted both *in vivo* and *in vitro* to elucidate the mode of action of thiourea.

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Physiology of                      H. B. D. SARKAR.  
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### POST-PARTUM PREGNANCY IN THE INDIAN FRUIT BAT - *ROUSETTUS LESCHENAUULTI* (DESM.)

AFTER the first report of Matthews (1939, 1942) about the occurrence of more than one pregnancy in the year in *Nycteris leucomela*, a few more species of bats have also been known to breed more than once in the year, viz., *Desmodus rotundus* (Wimsatt and Trapido, 1952), *Taphozous longimanus* (Gopalakrishna, 1954 and 1955), and *Cynopterus sphinx gangeticus* (Mondal, 1956). In *Desmodus rotundus* and *Taphozous longimanus* there is no restricted breeding season but the bats breed throughout the year. Further, the authors have led in compelling evidence to show that in these species there is a quick succession of pregnancies and that there is a physiological alternation of the two sides of the female genitalia in successive breeding cycles. It is interesting to note that all the species of bats which breed more than once in the year are tropical in their distribution. Barring these species mentioned above the bats are known to breed only once in the year in a sharply defined season.

The present communication embodies observations on certain peculiarities in the breeding

habits of *Rousettus leschenaulti* around Aurangabad, Maharashtra State. Although monthly collections to represent all the months of the year are being made, the pertinent details of only some of the collections are incorporated in the present paper. The data pertain to collections made between January through April 1964. The extract from the collection diary is given in Table I.

TABLE I

Date	Males	Females	Total
11-1-1964	15	21	36
27-1-1964	22	24	46
8-2-1964	22	30	52
28-2-1964	16	17	33
12-3-1964	8	24	32
22-3-1964	11	16	27
3-4-1964	10	27	37
5-4-1964	9	32	41
8-4-1964	10	13	23
13-4-1964	20	13	33
20-4-1964	7	16	23

In the non-pregnant females the genitalia resemble those in other megachiropteran bats, and consist of a pair of ovaries, a symmetrically placed bicornuate uterus forming the two lateral limbs of a 'Y' and the vagina forming the median limb of the 'Y'. The collection diary reveals the following facts:

Progressively advanced stages of pregnancy were observed in specimens collected between 11-1-1964 (early pregnancy) and 27-3-1964 (full term). In each pregnant female only one of the uterine cornua had the pregnancy and there was a single foetus. The pregnancy was either in the right cornua or in the left, there being no physiological dominance of either of the sides over the other. Of the 27 females collected on 3-4-1964, 15 had delivered and were carrying a young each in the breast. 13 of these had again become pregnant having embryos ranging from free tubal morulae to early uterine blastocysts. In every one of these cases the non-pregnant cornu was still in the post-partum condition suggestive of the fact that the previous pregnancy was borne in that cornu of the uterus. The other two females had not yet become pregnant after delivery. In these animals the uterine cornu of the previous pregnancy was still swollen and had a large blood clot indicating that they must have delivered a few hours before they were captured. This was further suggested by the very young ones at the breasts of the mothers.

An approximately similar situation as that of the collection made on 3-4-1964 was observed

in the collections made on 5-4-1964, 8-4-1964 and 13-4-1964. In each of these collections some had delivered and each one of these had again become pregnant and carried the new conceptus in the uterine cornu opposite to that in which the previous pregnancy had occurred. The number of females which had delivered was more than those which still carried the pregnancy progressively during these days. All the females collected on 20-4-1964 had delivered and had again become pregnant. In several cases the non-pregnant cornu of the uterus was unmistakably in the post-partum condition.

These observations lead to the following conclusions: (i) this species breeds more than once in the year; (ii) the specimens copulate within a very short period after delivering the young; (iii) only one side of the genitalia is functional in each cycle in the female and a single young is borne each time; and (iv) the two sides of the female genitalia become functional alternately in successive cycles.

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Dept. of Zoology, A. GOPALAKRISHNA  
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Arts and Science,  
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## PHYTOPLANKTON IN THE MADRAS COASTAL WATERS

For comparing the productivity of the different seas the concentration of the phytoplankton cells in a unit volume (1 litre or 1 metre<sup>3</sup>) of sea-water is a useful estimate. But such quantitative estimates for Indian waters are very meagre. Ganapathi and Subba Rao,<sup>1</sup> Subrahmanyam,<sup>2</sup> and Prasad and Nair<sup>3</sup> have reported the phytoplankton in quantitative terms for the inshore waters at Waltair, Calicut and Mandapam Camp respectively. The estimates for Calicut are based on vertical net samples as well as on centrifuged samples; those for Waltair on samples collected by filtering measured volumes of water through No. 30 bolting silk, while the Mandapam Camp samples were taken by sedi-

mentation followed by centrifugation. Subrahmanyam<sup>2</sup> has shown that the Calicut inshore area supports a very dense population of phytoplankton and that it is among the richest marine areas of the world.

Quantitative estimates of phytoplankton from the inshore waters of Madras obtained by the author during January-May, 1956, are presented in this note (Table I). The results are based on centrifuged samples of sea-water.

TABLE I  
No. of phytoplankton cells per litre of sea-water

	1956				
	January *(2)	February *(4)	March *(7)	April *(3)	May *(4)
<i>Chaetoceros</i> sp. ..	5900	145350	116100	30700	8400
<i>Asterionella japonica</i>	30600	770550	322170	124700	134050
<i>Skeletonema costatum</i>	160000	209750	6900	1700	4500
<i>Nitzschia closterium</i>	5800	46100	12800	3470	19350
<i>N. seriata</i> ..	2000	10020	3460	..	..
<i>Leptocylindricus danicus</i>	..	6900	22500	2800	..
<i>L. minimus</i> ..	7000	31350	28500	..	20000
<i>Coscinodiscus</i> spp. ..	..	..	540	70	150
<i>Rhizosolenia</i> spp. ..	..	20550	54440	1130	350
<i>R. stollerforthii</i>	3400	14400	1900	3730	1400
<i>Stephanopyxis</i> sp. ..	..	..	290	..	..
<i>Stretthotheca</i> sp. ..	800	750	30	130	300
<i>Thalassionema</i> sp. ..	..	3900	4900	6400	2500
<i>Hemiaulus</i> sp. ..	..	..	13060	270	..
<i>Biddulphia sinensis</i>	100	..	340	200	..
<i>B. mobilensis</i> ..	..	1200	640	470	550
Miscellaneous ..	9600	30050	29500	11700	10300
Total diatoms ..	225200	1290900	618100	187470	201850
<i>Ceratium</i> spp. ..	..	..	210	70	..
<i>Peridinium</i> sp. ..	..	600	740	270	50
<i>Prorocentrum micans</i>	..	2100	140	200	100
Total dinoflagellates	..	2700	1090	540	150

\* Figures within brackets indicate the number of centrifuged samples examined during the month.

It will be seen from Table I that the diatom population varied from 187,470 cells/l. in April to 1,290,900 cells/l. in February, whereas the dinoflagellates varied from 150 cells/l. in May to 2,700/l. cells in January. The species composition shows that the bulk of the diatom population was composed of small celled forms like *Skeletonema costatum*, *Leptocylindricus minimus*, *Nitzschia closterium*, *Asterionella japonica* and *Chaetoceros* spp. It also shows that the dinoflagellates formed only a very small fraction of the phytoplankton.

The present phytoplankton estimates are more or less equal to those given by Prasad and Nair<sup>3</sup> for the Gulf of Mannar (360 to 583,000 cells/l.), lesser than those given by Subrahmanyam<sup>2</sup> for Calicut (1.92 to 18.08 million cells/l. in centrifuged samples); but far exceed those given by Ganapathi and Subba Rao<sup>1</sup> for Waltair (80 to 24,432 cells/l.). Perhaps the lesser numbers reported at Waltair are due to the usage of a No. 30 bolting silk which might have resulted in the escape of the small-celled diatoms. The present data also compare favourably with published data (see Subrahmanyam<sup>2</sup>) for Plymouth Sound, Loch Striven, Kiel Bay, Great Barrier Reef lagoon, Woods Hole, La Jolla and Aomori Bay, excepting for the high numbers observed during spring and early summer at Loch Striven and Kiel Bay. Furthermore, a study of plankton collected by a horizontal plankton net during 1954-56 by the author at Madras (Muthu<sup>4</sup> unpublished) revealed that the first half of the year is generally poorer in phytoplankton than the second half. Hence, it is likely, that centrifuged samples during the second half of the year would yield higher estimates of phytoplankton density. It could be concluded that the Madras inshore waters are rich in phytoplankton.

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Central Marine Fisheries M. S. MUTHU  
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#### STUDIES ON CABBAGE LEAF MINER (*LIRIOMYZA BRASSICAE*, RILEY)

CABBAGE is attacked by several pests important amongst which are mustard sawfly (*Athalia proxima* K.), diamond back moth (*Plutella maculipennis* Curtis), aphids (*Brevicoryne brassicae* Linne).<sup>1</sup> Recently, however, leaf miner (*Liriomyza brassicae*, R.) (*F. Agromyzidae*, Diptera) is found to cause heavy losses especially in seedling stage of the crop. Incidence

to the extent of 30 to 40% is usually noticed while in case of heavy infestation seedlings in seed bed are destroyed completely and resowing is required to be done.

The species was referred to as *L. pusilla*, C. upto the year 1956, when Frick distinguished *L. pusilla*, C. and *L. brassicae*, R. as two distinct species.<sup>3</sup> It is a polyphagous and cosmopolitan species<sup>5</sup> recorded to feed on cabbage, cauliflower, knolkhol,<sup>9</sup> peas,<sup>2</sup> tomato,<sup>12</sup> tobacco,<sup>3</sup> onions<sup>1</sup> and pepper<sup>8</sup> in countries like U.S.A., Great Britain, Fiji Isles<sup>7</sup> and Hawaii.<sup>6</sup> In the Indian Union incidence of *L. brassicae* was recorded on cauliflower for the first time in Delhi by Spencer in the year 1961<sup>11</sup> and a brief note was published by Sehgal and Trehan in the year 1963.<sup>10</sup>

Studies on the life-history, etc., of the pest were undertaken at the Entomology Section, College of Agriculture, Poona, details of which are given below.

**Marks of Identification.**—Adult is minute-sized dipterous fly with yellowish body and dark brown head and legs. It measures about 2.5 mm. in length with a wing expanse of 3.00 mm. (Fig. 1). Eggs are elongate, translu-

yellow and becomes dark brown at the time of emergence of adult. It measures 1.8 × 0.6 mm.

**Host Plants.**—Besides the hosts mentioned earlier the radish (*Raphanus sativus*), safflower (*Carthamus tinctorius*), cucumber (*Cucumis sativus*), and methi [*Trigonella (Foenum) gracium*] were recorded as additional hosts.

**Nature of Damage.**—Female punctures a series of minute holes along the margin of tender leaves with its ovipositor. As a result the attacked portion dries up. Larvæ mine into the upper epidermis of leaf causing serpentine mines.<sup>5</sup> In case of severe infestation the seedlings are killed.

**Rearing Technique.**—Since the insect is an internal feeder, its life-history had to be studied *in situ*. Ten pairs of freshly emerged adults were selected for life-history studies. Each of these pairs was released on a potted cabbage seedling which was covered by a lantern glass. A muslin cloth was tied to the upper end of the glass. For recording the duration of larval and pupal periods only one egg was retained per seedling by destroying the rest, while for observing the egg-laying capacity of a female and incubation period of eggs, a fresh seedling was exposed to a pair every day till the death of the female. These seedlings were daily observed under microscope for recording the hatching percentage.

**Life-history.**—Copulation takes place immediately, after the emergence of adults. Pre-oviposition period is about 24 hours. Eggs are laid singly inside the leaf tissues along the upper margin of tender leaves. On an average a female lays about 36 eggs within a period of 5 days, the maximum recorded being 55 eggs per female.

**Egg.**—It is completely embedded in leaf tissues and the incubation period is 3-5 days (Average 3.5 days).

**Larva.**—Duration of larval period is 3-6 days (Average 4.12 days). Larva cuts a triangular opening on the upper surface of leaf, drops down on the ground and pupates in soil crevices at a depth of about ½" to ¾" from the surface.

**Pupa.**—Pupation takes place in the last larval moult. Pupal period lasts for about 9 to 11 days (Average 10 days). Adult emerges by breaking open the anterior end of the puparium.

**Adult.**—Female can be easily distinguished from the male due to the presence of broad and dark ovipositor. Males die immediately after copulation, while females continue to live for 6 to 9 days (Average 7.21 days). A generation is

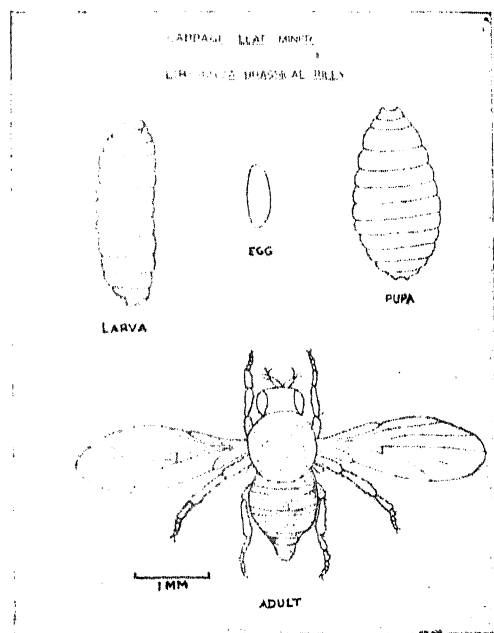


FIG. 1

cent shining and smooth, measuring 0.25 mm. by 0.1 mm. Freshly hatched larva is whitish which becomes yellowish when full grown and measures 2.1 mm. in length. Newly-formed pupa is yellowish in colour which later turns dark

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The two main reasons for the failure of the MRC to achieve its objectives are the lack of a strong and effective leadership and the lack of a clear and consistent policy. The MRC has been unable to develop a strong and effective leadership because it has been unable to attract and retain the best talent. The MRC has also been unable to develop a clear and consistent policy because it has been unable to reach a consensus on the MRC's objectives and priorities. The MRC has also been unable to reach a consensus on the MRC's objectives and priorities because it has been unable to reach a consensus on the MRC's objectives and priorities.

Abstract: The effect of the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid, on the formation of the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid, from the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid, is studied. It is found that the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid, is a good catalyst for the formation of the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid, from the  $\alpha$ -hydroxy acid, 2-oxo-3-oxopentanoic acid.

The increased use of the word "person" in the language of the human rights has been reported at the

During the month of November, 1964, a severe and extensive blight in leafy crops of *A. esculenta* Morch. was noticed at the Rice Seed Multiplication Farm, Kalam. The necrotic areas invariably yielded a pure culture of *Alternaria* sp. In the present note a short description of the disease and the causal organism is given.

**Symptom.**—The disease initiates as small, pale brown spots at the tips and margins of the leaflets, which gradually increase in size, ultimately covering the entire leaflet and thus giving a blighted appearance to it. In heavy attack most of the leaves on a plant become blighted and the plant ultimately succumbs to the disease.

**Morphology**—The hyphae are light brown to middle brown in colour, septate. The conidia



Herbaria Cryptogamia India Orientalis, and Indian Type Culture Collection of Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi, and at the Herbarium of the Mycology Section, State Agricultural Research Institute, Calcutta.

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# SOME OBSERVATIONS ON THE EMBRYOLOGY OF *BUPLEURUM TENUE* BUCH.-HAM. EX D. DON

WHILE the majority of the Umbelliferae studied so far exhibit monosporic embryo-sacs, bisporic development has been reported in *Bupleurum aureum*.<sup>1</sup> Recently, Marano<sup>2,3</sup> observed Polygonum type in *B. spinosum* and *B. dianthifolium*. The present communication deals with the embryology of *B. tenue* where also the embryo-sac is monosporic.

*Bupleurum tenue* is a small annual herb with simple leaves, and flowers are borne in compound umbels. The flowers are actinomorphic, incomplete, epigynous and pentamerous, with oligomeric gynoecium.

The anther wall comprises the epidermis, endothecium, one middle layer and secretory tapetum (Fig. 1 A, B). The endothecium shows characteristic fibrous thickenings not only in the four microsporangia but also in the region of connective on the dorsal side. The reduction divisions in the microspore mother cells of the four locules of an anther are non-synchronous. Cytokinesis takes place by furrowing and the tetrads may be tetrahedral or decussate (Fig. 1 C). The ellipsoidal pollen grains, with three germ pores each, are shed at the 3-celled stage (Fig. 1 D) and the gametes are mostly located at one of the poles. Paliwal's observation<sup>4</sup> that in the Umbelliferae the male cells are situated one at each pole may not be consistent in all the members.

Of the two pendulous ovules in each locule of the ovary, only one functions. It is uni-tegmic, tenuinucellate and anatropous. Two or three hypodermal archesporial cells differentiate in the nucellus but only one of them develops into the megaspore mother cell. It forms a

linear tetrad (Fig. 1 E, F) and the chalazal megaspore produces the embryo-sac (Fig. 1 G, H). The occurrence of Polygonum type of gametophyte in *Bupleurum tenue* warrants a reinvestigation of *B. aureum*<sup>5</sup> to confirm if the embryo-sac is really bisporic. The hypostase and endothelium develop at the megaspore tetrad stage and persist till shortly after the organization of the female gametophyte (Fig. 1 E-H).

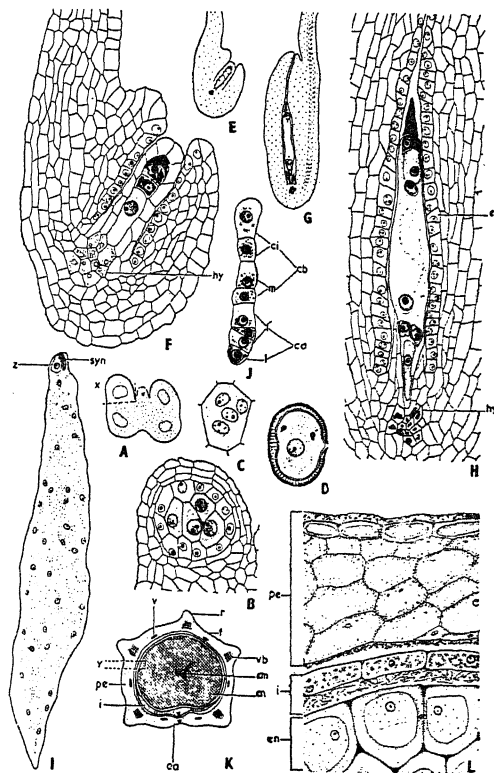


FIG. 1. A-L. *Bupleurum tenue*. A. T.S. anther at microspore mother cell stage,  $\times 157$ . B. Portion X magnified from A,  $\times 593$ . C. Microspore mother cell at Meiosis II,  $\times 1,187$ . D. Three-celled pollen grain,  $\times 1,187$ . E. LS ovule at megaspore tetrad stage,  $\times 157$ . F. A portion enlarged from E to show the developing endothelium (et) and hypostase (hy),  $\times 593$ . G. Longi-section of ovule with organized embryo-sac,  $\times 157$ . H. A portion enlarged from G,  $\times 593$ . I. 32-nucleate endosperm with zygote (z) and a degenerated synergid (syn),  $\times 593$ . J. An 8-celled proembryo,  $\times 503$ . K. T.S. of mericarp at dicotyledonous stage of embryo showing pericarp (pe), ridges (r), furrows (f), vittae (v), vascular bundle (vb), carpophore (ca), integument (i), cellular endosperm (en), and dicotyledonous embryo (em),  $\times 33$ . L. Portion Y enlarged from the region of a furrow in K,  $\times 593$ .

The endosperm is of the Nuclear type (Fig. 1 I) and centripetal wall formation is initiated at the 3 or 4-celled stage of proembryo.

[illegible]

The present report is the first record of  
 Coccidioides immitis groups under Petri on Rho-  
 nchococcus sp. from Florida.

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2. Marano, L., *Ann. Chim. (Milan)*, 1934, **61**, 201.
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water splashes, and (c) using dithiocarbamates such as Fermate, Dithane and Terlate in the place of Bordeaux mixture.

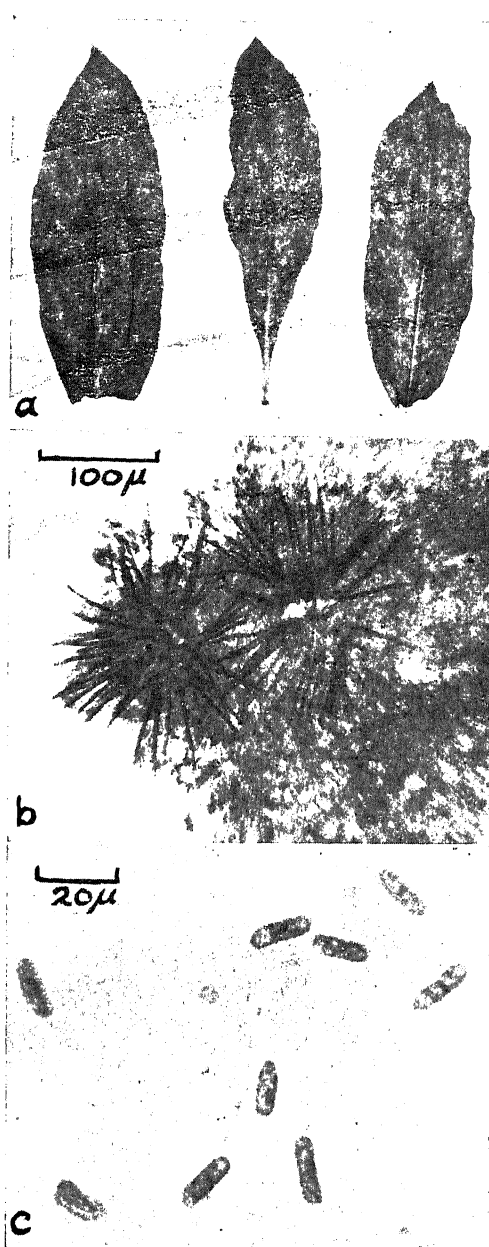


FIG. 1. Showing (a) the leaves of *Rantoulia serpentina* damaged by *Colletotrichum gleosporioides*; (b) acervuli of *C. gleosporioides* and (c) conidia of *C. gleosporioides*.

The author wishes to express his grateful thanks to Prof. J. M. Fogg, Jr., Director, The Morris Arboretum, Philadelphia, USA, for his keen interest and valuable criticisms; to Olin Mathieson Chemical Corporation for the award

of a research grant and to the University of Pennsylvania for providing facilities for work.

Division of Botany, P. D. VARADARAJAN.  
Sarabhai Chemicals Research Institute,  
Ahmedabad-4, May 20, 1964.

\* This work was carried out at the Morris Arboretum, Philadelphia 18, Pa., USA.

\*\* This plantation was situated in Tapachula, Mexico.

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#### ALBUGO PESTIGRIDIS—A CORRECTION

THE name claimed to be a new species of *Albugo*, namely *Albugo pestigradis* (Verma) Gharse Sp. Nov.<sup>1</sup> is wrong and is against the fundamental principles of the International Rules of Botanical Nomenclature. As is necessary in the case of a new species, a Latin rendering of the description is given. But if it is a new species described for the first time by Gharse, the name of Verma should not be given in parenthesis. Gharse can give Verma's name in parenthesis only if the specific epithet *pestigradis* was used by Verma in connection with some other generic name and Gharse considers it to be an *Albugo* and transfers that specific epithet to *Albugo*. But in such a case, it is not a new species (Sp. Nov.), but a new combination, and the Latin description is not necessary. On the other hand, it should be indicated when and where, and for which genus, Verma used the specific epithet *pestigradis*. In the present case Verma had obviously nothing to do with the species being described by Gharse, and his name should not be associated with it. Moreover, Gharse states that his description is an "emended" one. The fact is that Gharse is giving his own description of what is claimed by him to be a new species, and he is not "emending" anybody else's description, for if it is a new species, how does emending arise? Without going into the validity of his identification, the name of Gharse's species should be *Albugo pestigradis* Gharse.

Ramnarain Ruia College,  
Bombay-19, September 12, 1964.

V. S. RAO.

1. Gharse, P. S., *Curr. Sci.*, 1964, **33**, 285.

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REVIEWS

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**Nuclear Shell Theory** (Volume 14 of Pure and Applied Physics). By Amos de-Shalit and Igal Talmi. (Academic Press Inc., 111, Fifth Avenue, New York 3), 1963. Pp. 573. Price \$ 14.50.

Many features of nuclear structure have been understood in the past decade by the use of the Jensen-Mayer Shell Model, and its modified and improved versions, made possible through the development of methods of tensor algebra for the application of these models to complex systems. This book presents these powerful techniques in a systematic way, developing in parallel their applications to nuclear shell theory and to some problems in atomic spectroscopy. In this manner, the presentation of this important mathematical tool is interwoven with some of its most useful applications, giving a keener appreciation of the tool itself as well as a deeper insight into the nuclear shell model.

This volume is intended for graduate students and scientists working in the areas of low energy nuclear physics, atomic spectroscopy, and other fields of physics in which these modern techniques are becoming essential as the natural methods to be used in systems of rotational symmetry. In the first two parts of the book, intended for non-theorists as well as theorists, the physical meaning of the various mathematical notions is stressed in order to develop an intuitive approach for the estimation of various processes. The third part, intended primarily for theorists, treats the more complicated problems of many-particle systems with illustrations and applications from the nuclear shell model. The Appendix includes a collection of useful formulas for work in this field.

C. V. R.

**The Proteins: Composition, Structure and Function** (Second Edition, Volume I). Edited by Hans Neurath. (Academic Press, Inc., 111, Fifth Avenue, New York 3), 1963. Pp. 665. Price \$ 22.00.

The first edition of this work in four volumes appeared ten years ago. Since then the field of protein chemistry has progressed at a revolutionary pace. In the light of the fundamental advances made during this period, it appeared neither practical nor desirable merely to expand and update the first edition, chapter by chapter.

The present edition is thus a completely new work in which fresh approaches are made to the subject of protein chemistry and particular emphasis is laid on the relations between protein composition, structure and function. Quantitative relationships are stressed rather than an encyclopedic coverage of the field.

The aims stated above show up very clearly in the first volume now under review. Indeed, the immense activity of the last decade is reflected in every one of the individual chapters of this volume. Chapter 1 by Albert Light and Emil L. Smith deals with Amino-Acid Analysis of Peptides and Proteins; Chapter 2 by Klaus Hofman and Panayotis G. Katsoyannis deals with Synthesis and Function of Peptides of Biological Interest; Chapter 3 by Joseph S. Fruton deals with the Chemical Aspects of Protein Synthesis; Chapter 4 by Robert E. Canfield and Christian B. Anfinsen deals with Concepts and Experimental Approaches in the Determination of the Primary Structure of Proteins; Chapter 5 by R. Cecil deals with Intramolecular Bonds in Proteins under the sub-head I: The Role of Sulfur in Proteins and Chapter 6 by Harold A. Scheraga deals with Intramolecular Bonds in Proteins under the sub-head II: Non-covalent Bonds.

C. V. R.

**Introduction to Modern Biochemistry.** By P. Karlson. Translated from the German by Charles H. Doering. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xvi + 433. Price \$ 10.00.

As the title indicates, the purpose of the book is essentially didactic. It emerged from the experience of the author over a course of years in teaching physiological chemistry, first at the Tubingen University and later at Munich.

The book aims to present biochemistry as a part of the science of life and the material contained in it has been selected and arranged on that basis. The following list of chapter headings may serve to indicate the manner in which the field is sought to be covered: I. Organic Chemistry and Biochemistry; II. Amino-Acids; III. Peptides; IV. Proteins; V. Enzymes and Biocatalysis; VI. Coenzymes; VII. Nucleic Acids and Protein Biosynthesis; VIII. Metabolism of Proteins; IX. Porphyrins

and Hemins; X. Biologic Oxidation-Metabolism of Oxygen; XI. Carbon Dioxide Formation in the Citrate Cycle; XII. Fats and Fat Metabolism; XIII. Phosphatides, Cerebrosides, Gangliosides; XIV. Isoprenoid Lipids: Steroids and Carotenoids; XV. Simple Sugars, Monosaccharides; XVI. Photosynthesis; XVII. Glycosides, Oligosaccharides, Polysaccharides; XVIII. Correlations in Intermediary Metabolism; XIX. Topochemistry of the Cell; XX. Hormones; XXI. Mineral Metabolism; XXII. Nutrition and Vitamins; XXIII. Special Biochemical Functions of Certain Organs.

It is evident that the book seeks to organise the vast material of present-day biochemistry according to the newer points of view and with particular regard to the current problems of the subject. It should, therefore, be of great value alike to teachers and to students of biochemistry.

C. V. R.

**Two New Methuen's Monographs: *Mechanical and Electrical Vibrations*.** By J. R. Barker, 1964. Pp. vi + 222. Price 21 sh; *The Nuclear Reactor*. By Alan Salmon, 1964. Pp. 141. Price 16 sh.

These two 1964 additions to the *Methuen's Monographs* on Physical Subjects come up to the usual high standard of the series and fulfil its aim admirably in presenting a clear and succinct account of the titles chosen, under coherently connected chapters and sections.

Vibrations and waves are of greatest importance in engineering and science. Vibrations are a nuisance in mechanical engineering, while the electrical engineer exploits vibrations and waves to pass information and energy between distant places.

The first book links up mechanical and electrical vibrating systems and develops the theory and applications to a variety of cases. The chapters on gyrators and transducers bring the subject-matter up to date.

The book on nuclear reactors covers the subject from the fundamentals of fission to the physics of control and shielding, and includes useful chapters on heat transfer, reactor as a source of radiation, and future developments as sources of power.

**Lake Baikal and Its Life.** By M. Kozhov. (In *Monographie Biologie*, Vol. XI.) (Dr. W. Junk, The Hague), 1963. Pp. 344. Price \$ 10.00.

Study of the life in any water mass, however small, is always interesting; when observations

are carried out for some years, not only our knowledge of several fundamental aspects enlarged, but the scope for exploitation of the resources therein emerges. The book under review goes even farther; it is a compilation of the publications and the original work of the author himself, based on a study of one of the largest freshwater lakes of the world (31,500 km.<sup>2</sup> area) and the deepest (bottom 1,285 m. below sea level), a water mass studied for more than 200 years and intensively for the last 50 years; not only that, the book brings under one cover in *English* all that has been published (about 1,000 publications are reported to have appeared on the Lake) about Lake Baikal, which being mostly in Russian has remained a closed book to most workers outside Russia. The only other comparable book is on Lake Ohrid in the Balkans (*The Balkan Lake Ohrid and Its Living World* by S. Stankovic, Dr. W. Junk, The Hague)—a tiny lake compared with the Baikal.

In a concise introduction, the reader is made familiar with the subject-matter dealt with under different heads—geography; hydrology; fauna and flora, their distribution and spread; life in the water—planktological aspects and fisheries; the history of the lake, its fauna and their evolution. A chapter gives the conclusions. There is a bibliography of over 500 references, organism and subject indices.

The picture emerging is that not only of a museum of living antiquities but of a vast centre of autochthonous specialization which continues at present as well. The geological changes over millions of years have brought about a unique world of organisms; over 1,200 species of animals and 500 of plants have been recorded, of which two-thirds live in the open water; of the 842 in the open waters, 82% are exclusive to Lake Baikal. All the phyla of animals and plants are represented. A number of species of commercially important fishes thrive in its waters. Light is thrown on the evolution of aquatic organisms, the formation of endemic complexes, biological and biogeographical problems. Lake Baikal has been aptly described as a gigantic natural laboratory.

From some recent accounts, Lake Nyasa in Africa, another of the largest lakes, now under study, promises to be equally interesting.

The book brings into focus how much can be gained by a systematic thorough study of the inland water masses. According to the author, only the fringe of the problems has been attacked so far; for example, it is found that organic production—algal crop—varies from year to

year as in the continental and sea basins, but the factors concerned in this remain little known.

We have in India now and are going to have soon many more extensive water masses—lakes—as a result of the impounding of the river systems. In addition to utilizing the water for irrigation and generating power, these waters can be made productive and fish reared. Some modest attempts appear to have been made in this direction, but serious thought does not appear to have been bestowed.

The author and publishers are to be congratulated in bringing out such a useful and thought-provoking book. The printing and get-up are excellent including some coloured illustrations.

R. SUBRAHMANYAN

**The Role of Science in the Development of Natural Resources with Particular Reference to Pakistan, Iran and Turkey—A Symposium held under the auspices of the CENTO Scientific Council, Lahore, January 1962.** (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. xix + 454. Price 50 sh.

The above was the theme of the symposium which was held in January 1962 in Lahore (Pakistan) under the auspices of the CENTO Scientific Council. Over 100 scientists, mainly from Pakistan, but including 25 specialists from U.S., U.K., Iran and Turkey took part in the symposium and discussed a range of topics relevant to the purpose of the symposium. Those included power and atomic energy, water resources, forestry and land use, agriculture and soil, wood and plant products, animal health and public health. Solutions were suggested to some specific regional problems raised at the symposium. This publication will be useful not only to the countries concerned but also to other underdeveloped countries which have similar problems to face.

A. S. G.

**Infrared Absorption Spectra—Index for 1958-62.** By H. M. Hershenson. (Academic Press, New York), 1964. Pp. 152. Price \$12.00.

This volume provides a five-year supplement to the original *Infrared Absorption Spectra: Index 1945-57* which was reviewed in this Journal (see *Curr. Sci.*, 1959, 28, 504) in the year of its publication.

The chief aim of the index as mentioned in the last review is to provide a means for the location of published absorption spectra of chemical compounds. The index is arranged

according to the compounds whose spectra are given, and the substances have been arranged alphabetically following, in the main, the *Chemical Abstracts* nomenclature.

The present supplement Index contains about 20,000 references to infrared absorption spectra published during 1958-62. Each reference indicates the journal, volume and page where an actual spectrum of the compound is reproduced. The literature coverage has been increased substantially and it now includes 66 journals against 33 in the original.

#### Books Received

*Information and Information Stability of Random Variables and Processes.* By M. S. Pinsker. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. xii + 243. Price \$10.95.

*Variational Methods for the Study of Non-Linear Operators.* By M. M. Vainberg. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. x + 323. Price \$12.95.

*Partial Differential Equations of Mathematical Physics* (Vol. 1). By A. N. Tychonov and A. A. Samarski. (Holden-Day, Inc., 728, Montgomery Street, San Francisco), 1964. Pp. 380. Price \$11.75.

*Relativity Groups and Topology.* By C. De Witt and B. S. DeWitt. (Gordon and Breach, New York-11, N.Y.), 1964. Pp. xvi + 929. Price: Paper \$9.50; Cloth \$19.50.

*Advances in Analytical Chemistry and Instrumentation* (Vol. 3). Edited by C. H. Reilley. (John Wiley & Sons, Inc., New York, N.Y.), 1964. Pp. vii + 523. Price \$15.00.

*Modern Developments in Electron Microscopy.* Edited by B. M. Siegel. (Academic Press, 111, Fifth Avenue, New York-3), 1964. Pp. xiii + 432. Price \$13.50.

*Physical Acoustics Principles and Methods* (Vol. 1, Part A)—*Methods and Devices.* By W. P. Mason. (Academic Press, 111, Fifth Avenue, New York-3), 1964. Pp. xii + 515. Price \$18.00.

*Electron Paramagnetic Resonance.* By S. A. Al'tshuler and B. M. Kozyrev. (Academic Press, 111, Fifth Avenue, New York-3), 1964. Pp. xi + 372. Price \$13.00.

*Man Microbe and Evolution.* By S. C. Seal. (Dr. S. C. Seal, 70/B, Jatin Das Road, Calcutta-29), 1964. Pp. viii + 103. Price Rs. 5.00.

*Progress in Organic Chemistry.* Edited by J. Cook and W. Carruthers. (Butterworth & Co., London W.C. 2), 1964. Pp. vii + 256. Price 57 sh. 6d.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

The University of Bombay has awarded the Ph.D. degree in Physics to Shri R. P. Sharma for his thesis entitled 'Investigations of Some Nuclear Energy Levels, Internal Conversion Coefficients and Shapes of Beta Spectra' and to Shri Girish Chandra for his thesis entitled 'Nuclear Energy Levels and Angular Distribution of Gamma Radiations from Nuclei'.

### Seminar on 'Recent Advances in Optics and Their Applications in Defence'

Seminar on "Recent Advances in Optics with particular reference to their Applications in Defence" will be held at the Instruments Research and Development Establishment, Dehra Dun, under the auspices of the Defence Research and Development Organisation on the 30th and 31st October, 1964. The Seminar will be presided over by Dr. S. Bhagavantam. The following topics have been included for discussion during the Seminar: (a) Fibre Optics and its applications, (b) Lasers and their applications, (c) Infra-red optics and its applications, (d) Modern trends in optical image evaluation, (e) Recent developments in interferometric techniques and their applications.

Scientists desirous of taking part or of contributing papers are invited to write to Dr. C. S. Rao, Director, Instruments Research and Development Establishment, Dehra Dun, so as to reach him not later than the 10th October, 1964.

### National Zoological Collections of India

The Standard Zoological Collections at the Zoological Survey of India have been built up over a century and include the collections of the former Natural History Section of the Indian Museum, Calcutta, as well as of the Asiatic Society of Bengal. They contain standard or authentically identified collections by world specialists and cover all groups of animals such as the Protozoa, sponges, corals and several other marine groups, the molluscs, insects, Crustacea, fishes, reptiles, birds and mammals and also include the pre-historic animal remains from various ancient sites in India. These are preserved in a variety of ways both dry and wet, and number over 600,000 specimens, including many unique and other type-specimens.

The collections are indispensable not only for the identification and naming of the fauna of the Indian Region but also contribute greatly to the growth and development of general zoological studies in India. They are also important from the point of economic and industrial zoology such as the fisheries, pests of agriculture and forestry, animal husbandry, transmission of human and animal diseases, and the study of commercial insects such as the silkworms, the honey-bees and the lac insects.

According to a Gazette of India Notification dated 11th July 1964, these Standard Zoological Collections will be called the *National Zoological Collections of India*.

### Control of Collar Rot of Groundnut

Messrs. K. N. Sahasranaman and K. Radha, Central Coconut Research Station, Kayamkulam, write as follows: Severe incidence of *Sclerotium rolfsii* Sacc. causing Collar rot of *Arachis hypogaea* var. *oleifera*, bunch type grown as an intercrop in coconut garden was successfully controlled by the application of Vapam (Sodium N. Methyl dithiocarbamate) at the rate of 3.5 gal. per acre. Significant reduction in pre-emergence rot (100%) and post-emergence infection (21.4%) were recorded in the Vapam treated plots. The soil treatment increased the yield of groundnut to the extent of 1.17 kg. per 100 plants.

### Observations on the Moulting of Deep-Sea Crustaceans

The moults cast off by deep-sea crustaceans represent a tremendous amount of organic material added daily to the rain of materials, known as detritus in the sea. For example, each euphausiid shrimp, a deep-sea plankton, contributes its full body-weight in cast moults every 50 days.

The above conclusion has been arrived at as a result of laboratory studies on the moults and moulting frequencies of *Euphausia pacifica*.

*E. pacifica* is an important and ubiquitous component of the deep-sea plankton in a broad oceanic region ranging from the north of Japan across the Bering Sea to Baja, California, Mexico. In the laboratory *E. pacifica* has been kept alive for more than 7 weeks on a diet of

the green flagellate *Dunaliella primolecta* and/or *Platymonas subcordiformis*.

Each animal, ranging in dry weight from 1.2 to 4.8 mg., was kept in one litre of sea-water. The water was changed every three days, and a drop of algal suspension was added daily. The containers were examined daily for cast off moults. Results showed that within the range of experimental temperature 9°–14° C., the moulting frequency was about 5 days (range 4–7 days) and each cast moult averaged 10% of the animal's dry weight. One animal lived 50 days in the laboratory and had passed through 11 moults, while another of similar size (1.3 mg.) went through 10 moults in 36 days. Ash weights averaged 54.4% of the moult dry weight and the organic components 45.6% by difference. If moulting occurs in the sea as frequently as it has been observed in the laboratory, then the moults of planktonic crustaceans could contribute a substantial portion of organic detritus in the sea.—(*Nature*, 1964, 203, 96.)

#### Chromium Oxide-Chromium Cermets

'Cermets' is the general name given to metal-ceramic mixtures. Their preparation and properties have come for much investigation of late. It has been reported that unusual shrinkage is noticed in the preparation of chromium cermets by partial reduction of refractory oxides. The method consists of pressing a mixture of chromic oxide and carbon, both in the finely divided state, into compacts and sintering to temperatures in the range 1400°–1600° C. in a vacuum of about  $10^{-4}$  mm. mercury. The amount of carbon is calculated to give 1–10% metallic chromium in the sintered body.

Under the above conditions, considerable shrinkage of the compact occurs, resulting in an increase of density in a typical case from 3.3 to 4.7 g./c.c. This can be compared with the increase in density from 3.2 to 3.4 for pure oxide sintered to the same temperatures. The increase in sintered density is accompanied by

an increase in compressive strength from 3 tons/in.<sup>2</sup> for the oxide to approximately 20 tons/in.<sup>2</sup> for the cermet.

The proportion of carbon plays a critical role in the properties of the cermet formed. Less than a threshold addition produces no effect, whereas more than the optimum causes the density and compressive strength to fall off, though less markedly. The latter deterioration is presumably due to an expansion effect of the carbon monoxide involved.—(*Nature*, 1964, 203, 70.)

#### Production of Free-Radicals in Biological Specimens by Laser-Irradiation

The effects of laser irradiation on materials of many kinds have recently become the subject of study in many laboratories. In particular, the effects of non-linear interactions in biological materials in the presence of the intense high-frequency fields of the laser light will be of significance, apart from theoretical considerations, from the point of view of the hazards to which personnel operating laser facilities may be exposed.

It is well known that other agents such as X-ray and  $\gamma$ -ray irradiation, as also electron beams produce free-radicals in biological materials. Investigations were undertaken to find out if similar effects are produced by laser light.

Four types of materials were investigated: White and black mouse skin, mouse liver, and preparations of enzymes homolysin and collagenase. Electron-spin resonance method was used to detect the free radicals produced. Samples were irradiated with a ruby laser, with a nominal output of 100 J, and frozen with liquid hydrogen. Later they were examined by the ESR spectrometer.

Preliminary results indicate with high probability that free-radicals are generated in black mouse skin and homolysin as a result of ruby laser irradiation.—(*Applied Optics*, June 1964, p. 786.)



# THE NEW PHYSIOLOGY OF VISION

## Chapter II. Visual Sensations and the Nature of Light

SIR C. V. RAMAN

THE special organs of sense are the gateways through which a knowledge of external circumstances and events finds its way into the domain of human consciousness. Such knowledge is, of course, a prime requisite for the work-a-day activities of the individual. There is another role which the sense-organs play which is also of high significance, *viz.*, the special contributions they make to æsthetic values in human life. We may mention here music as perceived through the organs of hearing, perfumes through the sense of smell, and colour through the organs of vision. The study of these special aspects of perception naturally takes a very prominent place in the physiology of the respective sense-organs. It is significant that all the three faculties of perception exhibit certain common features, *viz.*, their ability to function over a wide range of intensities of the external stimuli and the capacity, in appropriate circumstances, to notice them even when they are excessively feeble. We may also mention the rapidity with which the sense-organs function and the power which they possess of recognising even subtle differences in the characters of the exciting stimulus. All these features enhance the usefulness of the sense-organs in human life and activity.

The position of exceptional importance which vision takes amongst the faculties of perception is attributable to the special properties of the physical agency, *viz.*, light, which our eyes make use of and which enables them to function. There are obvious relationships between these properties and the services which the faculty of vision can render. For example, light can travel swiftly through vast distances in space and still reach us and not disappear on the way. We are thereby enabled, with our unaided vision, to perceive very distant objects, even those lying outside our own galactic universe, as for example, the Great Nebula in Andromeda. The rectilinear propagation of light in space is evidently also what makes it possible for us to locate various near objects around us. The differences in the spectral character of the light which reaches us, either from the original sources or from the objects

which reflect, scatter or diffuse the light falling on them is likewise the basis on which rests the special faculty of colour perception. From all that has been said, it follows that the physiology of vision is greatly concerned with the nature and properties of light, and unless these are known and correctly understood, those pursuing the subject would be wandering about on false trails.

*Light Plays a Dual Role.*—At the end of the nineteenth century, the nature of light was regarded as an issue which had been settled once for all. The view adopted was that light is wave-motion which travels in free space with a velocity approaching 300,000 kilometres per second. The electric and magnetic forces constituting the disturbance are mutually perpendicular and appear in a plane transverse to the direction of propagation of the waves. Monochromatic light is in the wave-theory characterised by a definite wavelength in vacuum and a correspondingly high but definite frequency of variation of the electric and magnetic forces. In view of what has been said above, one need not be surprised that the great leaders of scientific thought in the nineteenth century who were principally responsible for advancing and establishing the wave-theory of light also sought to interpret our visual perceptions on the same basis. They could not have foreseen that all such attempts were foredoomed to failure.

As is well known, a revolutionary change in our ideas regarding the nature of light was brought by the work of Albert Einstein in the early years of the twentieth century. Einstein revived the idea favoured by Newton in an earlier epoch of science, *viz.*, that light is corpuscular in nature, but he put it forward in a modified form having both substance and definiteness. The light-corpuscles of Einstein represent specific amounts of energy in the radiation field, the quantum of energy being the smallest for light appearing at the red end of the spectrum and increasing continually as we proceed towards its violet end, being in fact proportional to the light-frequency. The support forthcoming for these concepts from many

different directions has been so overwhelming that Einstein's ideas are now a well-established part of scientific knowledge.

The corpuscular and wave-theoretical descriptions of light seem at first to be mutually contradictory. But as they are both supported by great arrays of factual evidence, a way of reconciling them has necessarily to be found. Such reconciliation becomes easiest if it be assumed that the two concepts are valid in completely different and mutually exclusive fields of experience. Wave-optics successfully describes the propagation of light in free space, its reflection and refraction at the boundaries between the two media, and the special effects known as interference and diffraction which are characteristic of wave-motion and which arise from the superposition of wave-disturbances from the same original source. The corpuscular concept, on the other hand, is essential for the consideration of all phenomena in which there is a transference of the energy of radiation to or from material bodies. The emission and absorption of light are examples of such phenomena, and they can be successfully described and explained only on that basis.

The corpuscular concept of light involves a further and quite fundamental change in our modes of scientific thinking. This also we owe to Einstein. The emission or absorption of light by an atom or molecule, in the corpuscular concept, is not a continuous process but an individual event, and whether this occurs or not is a matter of chance. All that we can specify about it is the probability of its occurring, and hence the observable phenomena arising from such events can only be described in statistical terms.

What has been stated above is of the utmost significance in relation to vision. The dioptrics of the eye and the formation of focussed images of external objects on the retina clearly fall within the scope of wave-optics. But wave-

optics is irrelevant in all considerations regarding the actual perception of light. Interactions of some kind between the incident light and the material present in the visual receptors are clearly needed for such perception to be possible. It follows that all aspects of vision including the perception of space and form, the perception of luminosity and the perception of colour, can only be understood in terms of the corpuscular concept of the nature of light.

It needs here to be stated and emphasized that the quantum of energy which a corpuscle of light represents is an exceedingly small quantity by all ordinary standards. For example, for light of the wavelength 555 m $\mu$  which lies in the green part of the spectrum, it is  $3.566 \times 10^{-12}$  of an erg. For longer and shorter wavelengths, the quantum is respectively smaller and larger, being in an inverse proportion to the wavelength. From these figures, and the known mechanical equivalent of light energy, a simple calculation enables us to find the number of light-quanta falling per second on unit area of an illuminated screen. Taking the strength of the illumination to be one metre-candle, in other words, one lumen per square metre, and that one lumen of illumination with light of wavelength 555 m $\mu$  is equivalent to 0.00154 watts of energy, the quantum of light energy of that wavelength comes out  $3.566 \times 10^{15}$  watt-second. Hence, the screen would receive per second  $4.3 \times 10^{15}$  quanta per second per square metre of its area. This is an enormously large number.

In the following chapter we shall survey broadly the consequences which follow from a recognition of the corpuscular nature of light and discuss the role that it plays in our visual perceptions. In doing so, we shall not hesitate to draw the various inferences which follow as logical consequences of that concept, taken either by itself or taken in conjunction with certain well-established results of experiment.

#### THE INDIAN ACADEMY OF SCIENCES, BANGALORE-6

**A**T the kind invitation of the University of Poona, the Thirtieth Annual Meeting of the Academy will be held at Poona on the 25th, 26th and 27th December 1964.

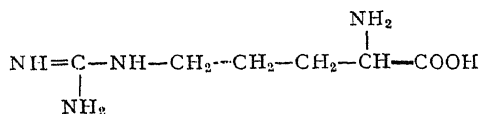
# X-RAY ANALYSIS OF L-ARGININE HYDROHALIDES

S. K. MAZUMDAR AND R. SRINIVASAN

Department of Physics, University of Madras, Madras-25

## 1. INTRODUCTION

THE investigation of the crystal structure of the amino-acid L-arginine



in the form of its hydrohalides was undertaken in this laboratory as part of a major programme of work on compounds related to proteins. Its structure has now been completely established and this is a short preliminary report of the work.

The hydrohalides studied were L-arginine hydrobromide and L-arginine hydrochloride. The latter was found to have two forms differing completely in their crystal data. One of these forms (which we refer to as Form I) was actually found to be isomorphous with the hydrobromide, which existed only in one form. The Form II of the hydrochloride differed from Form I in that the former had no water of crystallization. The crystallographic data of these compounds are given in Table I.

## 2. STRUCTURE DETERMINATION

The work was started first on the hydrobromide since it was hoped that bromine, being heavier than chlorine, could be located easily. Three-dimensional intensity data about the shortest *b*-axis were recorded on equi-inclination Weissenberg photographs with filtered  $\text{CuK}\alpha$  radiation. Data along the *c*-axis were also collected as a subsidiary set of cross-layer data. A similar procedure was adopted for the hydrochloride also. The intensities were estimated visually. The usual corrections for Lorentz and polarisation factors were made and the intensities were placed on the absolute scale by Wilson's method. No correction for absorption was made since the size of the crystal was chosen to be such that the absorption correction was negligible.

The first step in the determination of the structure was to calculate the Patterson function. As might be seen from Table I the asymmetric unit of the cell contains two molecules and hence two bromine atoms. The two bromine positions could be easily located from the Patterson projections on (010) and (001). The position of the two bromine atoms thus

TABLE I  
Crystallographic data for L-arginine hydrohalides

Compound	Space Group	<i>a</i> (Å)	<i>b</i> (Å)	<i>c</i> (Å)	$\beta$	Cell contents
L-arginine HBr ..	P2 <sub>1</sub>	11.26	8.65	11.25	91° 30'	4 (C <sub>6</sub> H <sub>14</sub> O <sub>3</sub> N <sub>4</sub> ·HBr·H <sub>2</sub> O)
L-arginine HCl (Form I) ..	P2 <sub>1</sub>	11.22	8.50	11.07	91° 00'	4 (C <sub>6</sub> H <sub>14</sub> O <sub>3</sub> N <sub>4</sub> ·HCl·H <sub>2</sub> O)
L-arginine HCl (Form II) ..	P2 <sub>1</sub>	5.33	9.46	20.07	90° 30'	4 (C <sub>6</sub> H <sub>14</sub> O <sub>3</sub> N <sub>4</sub> ·HCl)

Of the three crystals mentioned above the structure analysis of the isomorphous pair was first taken up and completed. The structure was solved essentially by using the beta-synthesis (Ramachandran and Raman, 1959; Raman, 1959 *a, b*; Srinivasan, 1961). It might be mentioned incidentally that this work provided a thorough testing ground for verifying the theoretical prediction of the relative superiority of the beta-synthesis over the usual heavy-atom method (Srinivasan, 1961; Ramachandran and Ayyar, 1963). Details of these and of the complete structure determination will be reported in a separate paper. The present note summarises only the main findings.

obtained were used to calculate a three-dimensional weighted beta-synthesis\* (Ramachandran and Ayyar, 1963) which has coefficients

$$W^2\beta \equiv W^2 (|F_0|^2 / |F_{Br}|) \exp i\alpha_{Br}$$

where

$$W = \frac{I_1(2X)}{I_0(2X)} \quad \text{with} \quad X = \frac{|F_0| |F_{Br}|}{\sum_{j=1}^L f_j^2}$$

*L* being the number of light atoms in the structure. The resultant three-dimensional map revealed completely the structure which was

\* The calculation of the beta-synthesis was done using the programme written for ELLIOTT-303 by Dr. V. Raghupathy Sarma whom we wish to thank here.

picked out with a ball and spoke model. There were a few spurious peaks in the map but they could be easily eliminated from stereochemical considerations.

The refinement of the structure proceeded at first by difference-Fourier syntheses on projections and later by three-dimensional least-squares methods. The value of the reliability index  $R$  for three-dimensional data has been brought down to 10.4%. In the case of the hydrochloride, the corresponding value of  $R$  is 13.9%. While both structures may require a few more cycles of refinement for complete convergence, the results, nevertheless, seem to be sufficient to reveal the main features and to confirm the general agreement between the structures. We give here the molecular structure and dimensions as obtained for the hydrobromide, since this corresponds to a lower  $R$ -value. Table II lists the fractional atomic parameters and the individual isotropic temperature factors of the various atoms. The interatomic distances and angles are shown in Fig. 1 which shows the two non-equivalent molecules in their relative positions as seen projected down the  $b$ -axis.

The interatomic distances and bond angles are all satisfactory. Corresponding bond angles and bond distances in the two molecules of the asymmetric unit also agree well with each other.

TABLE II  
Fractional atomic co-ordinates and individual temperature factors

Atom	$x/a$	$y/b$	$z/c$	$B (\text{\AA}^2)$
Br <sub>1</sub>	0.1679	0.2474	0.8726	1.91
O <sub>3</sub> (w)	0.1198	0.1341	0.5890	2.83
O <sub>2</sub>	0.5415	0.6654	0.3578	1.88
O <sub>1</sub>	0.6491	0.4493	0.4095	2.09
N <sub>4</sub>	0.0422	0.7509	0.9054	1.95
N <sub>3</sub>	0.1826	0.8771	0.7878	2.80
N <sub>2</sub>	0.1320	0.6117	0.7560	1.64
N <sub>1</sub>	0.5758	0.4511	0.6357	1.36
C <sub>6</sub>	0.1221	0.7405	0.8141	1.50
C <sub>5</sub>	0.1943	0.5955	0.6441	1.55
C <sub>4</sub>	0.3288	0.5681	0.6702	1.63
C <sub>3</sub>	0.3876	0.5510	0.5452	1.89
C <sub>2</sub>	0.5225	0.5710	0.5561	1.35
C <sub>1</sub>	0.5789	0.5610	0.4302	1.45
Br <sub>2</sub>	0.1284	0.8902	0.3623	1.53
O <sub>3</sub> (w)	0.1199	0.9724	0.0827	2.60
O <sub>5</sub>	0.5458	0.7647	0.8506	2.45
O <sub>4</sub>	0.6093	0.5324	0.8850	2.59
N <sub>8</sub>	0.0607	0.3648	0.4089	2.67
N <sub>7</sub>	0.2098	0.2665	0.2875	1.97
N <sub>6</sub>	0.1371	0.5186	0.2580	1.43
N <sub>5</sub>	0.5724	0.5601	0.1228	1.53
C <sub>12</sub>	0.1321	0.3888	0.3170	1.43
C <sub>11</sub>	0.1922	0.5435	0.1406	1.86
C <sub>10</sub>	0.3138	0.6172	0.1576	1.64
C <sub>9</sub>	0.3722	0.6213	0.0285	1.43
C <sub>8</sub>	0.5072	0.6632	0.0424	1.40
C <sub>7</sub>	0.5601	0.6569	0.9163	1.74

The two molecules are arranged parallel to the  $ac$  plane with their chains running diagonally.

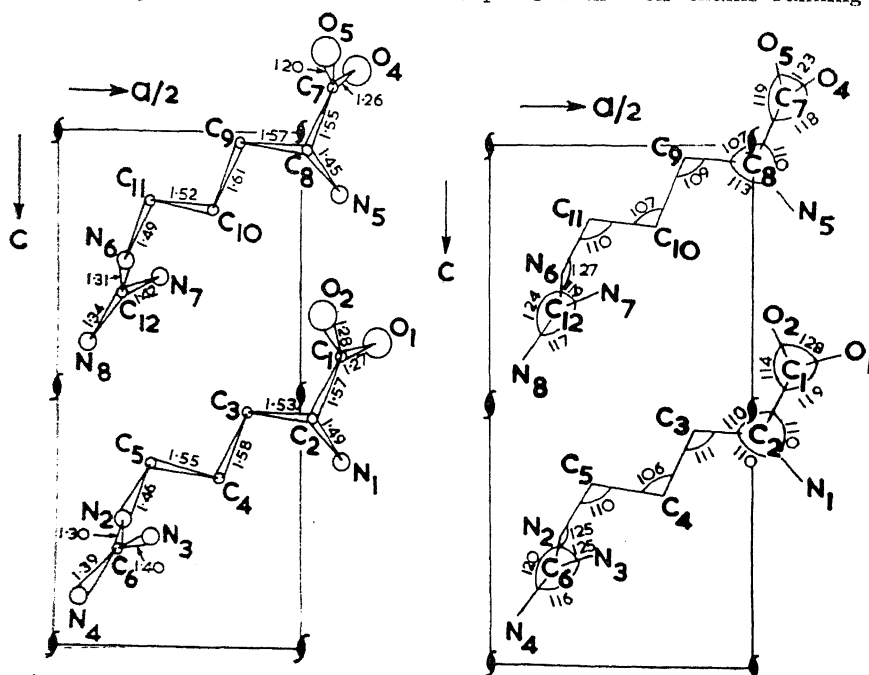
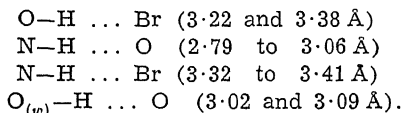


FIG. 1. (a) Bond Lengths and (b) Bond Angles in the two molecules of L-Arginine Hydrobromide as seen projected down the  $b$ -axis.

the exception being in the orientation of the guanidine groups. In one molecule the guanidine group ( $C_3N_2N_3N_4$ ) points upward along the positive direction of the *b*-axis, while in the other molecule this group ( $C_{12}N_6N_7N_8$ ) points downward along the negative direction of the *b*-axis. The two molecules when projected onto the *ac* plane are found to be separated by a translation of roughly *c*/2. The two molecules are linked together by a system of hydrogen bonds and also to the halogen ions and water molecules. The hydrogen bonds are of the types



### 3. ACKNOWLEDGEMENTS

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plying us a sample of L-arginine as a gift. The authors wish to thank Professor G. N. Ramachandran for his interest and encouragement during the course of this work. Our thanks are due to the Director of the Royal Institution for permitting us to carry out some calculations on the ELLIOTT-803 computer, and to Dr. V. Raghupathy Sarma for helping us to carry out the calculations with his programme. One of us (S. K. M.) wishes to thank the Council of Scientific and Industrial Research, India, for the financial help during the tenure of which this work was carried out.

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## NARMADA-SON LINE

K. BORDOLOI AND S. K. BOROOAH

Directorate of Geology and Mining, Shillong, Assam

ON the analogy of the crustal structure of South Africa, Ahmed<sup>1</sup> has tried to answer the question posed by West<sup>2</sup> as to the nature of the Narmada-Son line. The question is a complex one calling for more close study than has been given. Except around Hoshangabad and the Dhar forest, where it flows over Vindhyan outcrops, the Narmada for the greater part of its length flows south of the southern edge of the Vindhyan basin. In the northern area of the Son valley the junction of the Vindhyan with the metamorphics suggests an original limit of deposition of the sediments.<sup>3</sup> South-westwards near Kymore and Katni the Upper Vindhyan exhibit off-lap relation with the lower. Further south-west, where exposed near Hoshangabad and the Dhar forest, the Upper Vindhyan completely cover the Lower. On the northern border "the original limit of deposition is unmistakably exhibited by the overlap of the Kaimur group on to the gneiss and Bijawars".<sup>4</sup> Thus the land to the south of the basin was rising in the north-east<sup>5</sup> pushing the waters of the epeiric sea to the north and south-west. This possibly coincides with the Narmada-Bihar Tectonic unit of the Satpura Orogenic Belt of Holmes.<sup>6</sup>

No post-Archæan rocks are exposed in the Narmada Valley earlier than the Cretaceous of Barwaha and Bagh,<sup>7</sup> although a sea covered

Kutch in Jurassic times. Thus the Narmada trough appears to have been formed in post-Jurassic time or, if formed earlier, was sufficiently depressed only in Cretaceous times for the inlet of the Tethys-Madagascar gulf to enter it. According to Pascoe,<sup>8</sup> the large fault along the northern margin of the Mahadeva (Gondwana) basin seems to have marked the line along which a late fracturing was responsible for the formation of the Narmada Valley.

North of the Narmada-Son line, it is true, no coal-bearing Gondwanas have been exposed, but east of its prolongation coal-bearing Gondwanas have been exposed at the confluence of the Sonkosi and Arun in Nepal,<sup>9</sup> Sikkim,<sup>10</sup> Darjeeling and eastward up to NE Assam. Outcrops of Talchir boulder beds are, however, seen at Pokaran and Bap<sup>11</sup> lying on Vindhyan in Rajasthan, in the Salt Range, Hazara and Western Kashmir (Tanakki beds) all of which are west of the Aravalli Range which formed the watershed separating the drainage to the east and west. Away to the north of the line are the boulder beds of Simla (Mandhali beds) and Garhwal (Blaini Series). There is evidence to show that the fluvio-glacial Talcher boulder beds were laid down by glaciers flowing to the north and north-west; where the glaciers reached the sea a very poor and very special fauna

developed including *Conularia*, and especially a curious type of thick shelled pelecypod, the genus *Eurydesma*. The *Eurydesma* fauna is a fauna of cold seas, characteristic of the old shores of the Gondwana.<sup>12</sup> The *Conularia* and *Eurydesma* fauna has been recognized in the Salt Range, at Umaria and Manindragarh in M.P., at Khamgaon and Wak in Sikkim, and in the North-East Frontier Agency.<sup>13</sup> From the above, the coast-line of the Gondwana can be reconstructed as shown in Fig. 1.

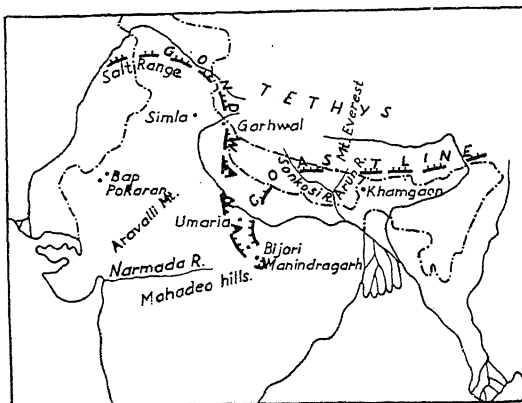


FIG. 1. Map showing Gondwana Coastline

All surviving basins of Gondwana rocks along the three systems of river valleys, viz., the Damodar, the Wardha-Godavari and the Mahanadi-Brahmani, owe their preservation from denudation to faulting on one or both sides of the basins. The Gondwana beds were laid in river valleys typical of a highly matured drainage system, impressed upon a floor planed to an undulating surface by the action of ice during the opening phase.

The absence of Gondwanas north of the Narmada-Son line may thus be due to either of two causes; either the conditions necessary for the formation of coal were not there, or that owing to lack of faulting the coal deposits formed were denuded away.

Physiographically, one of the most conspicuous features of the Gondwana period was the Aravalli range which formed the watershed between the drainage to the east and west. No mature drainage system could be developed close to the mountain. Away from the Aravallis, the country is today covered by the Indo-Gangetic alluvium. Recent aeromagnetic survey in the region between East Punjab and Bihar has given

indication of an uneven basement topography. The Ganga basin is segmented probably into 4 or 5 sectors parallel and sub-parallel to the Himalayan range. In some of these sectors the basement is reached within a shallow depth ranging up to 5,000 ft. with intervening portions containing huge thickness of sediments ranging between 20,000 and 30,000 ft.

What lies below the alluvium is not known and seeing that Gondwana coal seams have recently been found at Jaipurhati in Bogra district of East Pakistan at a depth of 3,000 ft.<sup>14</sup> below the alluvium one is almost tempted to say that similar may be the experience here. It is, however, significant that unlike the side east of the prolongation of the Narmada-Son line, where Gondwana coal seams have been discovered in the lesser Himalayas of Nepal and Sikkim, no coal seams have been discovered west of this line, although the Blaini Boulder bed has been traced for more than 100 miles from Subathu to the Madi Gad.<sup>15</sup>

The temporary inlet of the Tethys that laid the marine beds of Umaria-Bijori-Manindragarh region, in all probability, entered from the north and the land to the west appears to have had a topography not sufficiently subdued at the time by peneplanation to support a drainage system suitable for the formation of coal deposits.

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# MORPHOLOGY OF THE EMERGENCES

N. RAMAYYA

Department of Botany, Osmania University, Hyderabad (A.P.)

**A**LTHOUGH emergences constitute a category of appendicular structures of the angiosperms, our knowledge of their morphology seems to be quite meagre. Goebel (1900, p. 13) has aptly summarised the concept of emergence that had developed in the light of Goethe's theory of "Metamorphosis" as in the following: "The outcome of early and simple observations was the recognition of root, stem and leaf (foliage-leaf) as the chief vegetative organs of the higher plants. To these organs was added subsequently the hair, a structure springing from the epidermal cells and appearing as an appendage of the surface. When it was found that in the construction of many prickles and glands, layers of the tissue deeper than the epidermis were involved, the term 'emergence' was coined for them—a term, the definition of which is framed upon essentially negative characters: emergences are neither leaves, nor shoots, nor roots, and are not endogenetic." Eames and MacDaniels (1947) classify the emergences as appendages of the second rank while the foliar structures and trichomes as of first and third rank respectively.\*

Interpretation of the structure of emergences is also controversial. De Bary (1884) advocated that emergences are distinct from the trichomes because unlike the latter which are of epidermal origin, the former differentiate from cells derived both from the epidermis and hypodermal tissue. Netolitzky (1932) regarded the above distinction to be not feasible as the basal part of certain trichomes is of emergence nature. Presently the latter view seems to be in vogue.

Recently the present author, while dealing with the phylogeny and classification of the trichomes of the Compositae (1962), had by implication treated the trichomes to be distinct from the emergences. Such a view was taken on the basis of a comparative study of emergences of several angiosperms (those found on the leaves of *Solanum melongena* L. and *S. xanthocarpum* Schrad and Wendl.; on the involucre bracts enclosing the ray-florets of *Acanthospermum hispidum* DC.; and on the ovary of *Bixa orellana* L., *Triumfetta rhomboidea*

Jacq., *Datura fastuosa* L., *Momordica dioica* Roxb., *Caesalpinia bonducella* Flem., *Ricinus communis* L. and *Zornia diphylla* Pers.).

The study yielded important information concerning the nature of emergences and trichomes. While the detailed results would be published elsewhere, the salient observations made in these investigations are summarised in this paper. The comparative morphological characteristics of the emergences and trichomes based on these studies are given below.

**Structure.**—Emergences are multicellular and are differentiated into the epidermal, ground and vascular tissues. The epidermis consists of stomata and trichomes (Figs. 9 and 10) as found in the stem and other parts of the plant. The vascular tissue may consist of a single strand (as in *Acanthospermum hispidum*, Fig. 1) or several strands (as in *Datura fastuosa*, Figs. 8 and 11). The strands are not associated with any gaps (Fig. 11).

Trichomes may be uni- or multicellular but are without differentiation into the epidermal, ground and vascular tissues [descriptions that trichomes are vasculated found in the literature (e.g., Carlquist, 1959a) seem to be based on an interpretation which is not in agreement with the available evidence as discussed later].

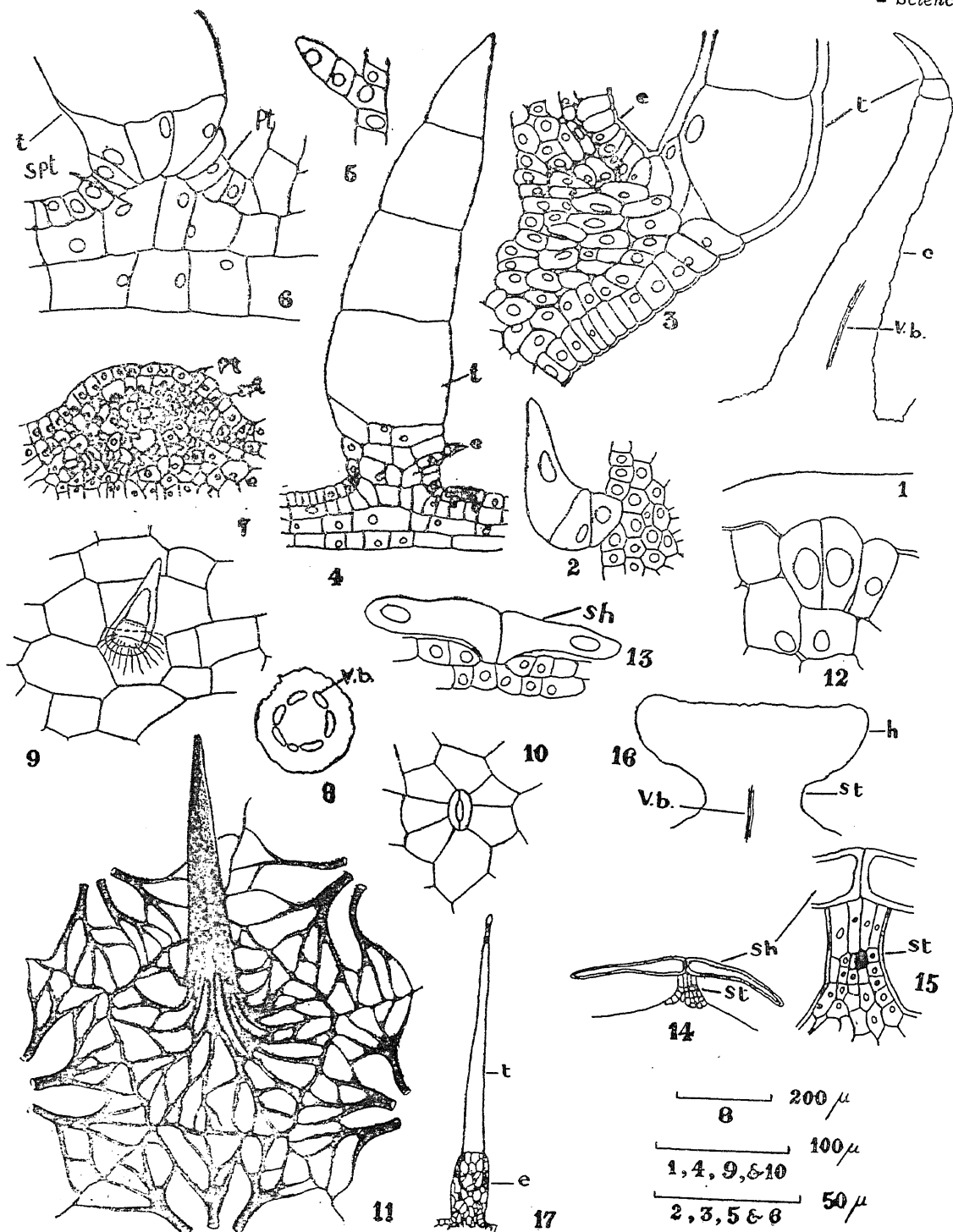
**Ontogeny.**—Both the protoderm and subprotodermal cells participate in the development of the emergences (Fig. 7). The protoderm through anticlinal divisions gives rise to the epidermis while the subprotodermal cells divide in all planes and differentiate into the ground and vascular tissues.

Trichomes originate from protoderm only. [Ontogenetic studies indicate that trichomes differentiate from single protoderm cells (De Bary, 1884; Ramayya, 1963). Carlquist (1959b, p. 302) in his study of the ontogeny of the "Sessile glands" of *Holocarpa*, however, describes that "there is no visible evidence that only a single cell is involved, although all the initials could conceivably have been derived ultimately from a single protodermal cell".]

**Organographic distribution.**—Emergences are borne by the stem and the various phyllomic appendages.

Trichomes are found not only on the stem and foliar structures but also on the emergences (Fig. 9).

\* The views of Bower (1935) and Zimmermann (1959) are not considered here as they were put forward primarily in connection with the pteridophytes.



FIGS. 1-17. Figs. 1-3 from l.s. involucre bracts enclosing the ovaries of ray-florets, *Acanthospermum hispidum*. Fig. 1. A mature emergence bearing a simple conical hair at its apex. Fig. 2. Early initiation of the above hair from a protodermal cell. Fig. 3. Development of the emergence following that of the overlying hair. Figs. 4-6.



It is obvious that emergences and trichomes of the angiosperms constitute two different structural categories for they show basic differences in respect of their structure, ontogeny and organographic distribution. Further, from the viewpoint of serial homology, emergences cannot be compared with the foliar appendages because they are borne by them also.

It is now necessary to examine the nature of the evidence on the basis of which the view that trichomes and emergences are not distinct structures is maintained (Netolitzky, 1932). It may be mentioned that emergences exhibit a wide range of variation in their size and structure so that they often appear variously modified and also without one or more of such features as the stomata, trichomes and vascular tissue. Some of the variants, however, become so peculiarly modified that they seem like trichomes or a part of them. It is on the evidence from these structures that the distinction between emergences and trichomes seems to have been regarded untenable. Therefore some examples of such modified forms are dealt with here explaining their true nature in the light of the overall evidence now available to distinguish between emergences and trichomes.

To begin with the instance is taken where an emergence bears but one trichome which lies at its apex as in *Acanthospermum hispidum* (Fig. 1). A modification from this is observed in cases where the emergence is much reduced and looks like the basal part of the overlying trichome itself. Fig. 4, from *Xanthium strumarium* L., represents an example of this kind. In ontogeny, however, the true character of these composite structures is revealed for the trichome is found to differentiate from a single protodermal cell and relatively earlier (Figs. 2 and 5), while the emergence is initiated afterwards due to the activity of several protodermal and subprotodermal cells surrounding the trichome (Figs. 3 and 6). The stinging hair of *Urtica* also

represents an example of this type, but in this the trichome itself is unicellular which stands embedded in the apex of an emergence (Fig. 17). Uphöf (1962), Foster (1949) and Solereder (1902) accordingly describe the stinging hair as borne on an emergence. The thorns of some Hawaiian Lobeliaceae also show a similar structure. As described by Carlquist (1962, p. 413) the thorns are "unicellular" trichomes raised on a conical mound of tissue derived from the ground meristem". Still more interesting is the instance where the emergence appears as the stalk of the overlying trichome. This is illustrated by the "peltate hairs" of *Shepherdia canadensis* (Fig. 14) described by Cooper (1932). According to him "the shield arises from a single epidermal cell whereas the stalk is from adjacent epidermal and hypodermal cells" (p. 473). It is obvious that the shield is a trichome because it originates from an epidermal cell (Figs. 12 and 13) while the stalk is an emergence being derived from both the epidermal and hypodermal cells (Fig. 15). In the examples so far described the emergence subtending the trichome is of non-vascular type. The so-called vascularized trichomes also present similar composite structures but consist of a trichome mounted on a vascularized emergence. For example Carlquist (1959a) describes the "terminal glands" of *Calycadenia* to be composed of a broad head supported on a vascularized stalk (Fig. 16). According to Carlquist (op. cit.) the head, however, differentiates from a protodermal cell, while in the development of the stalk "cells other than the protoderm participate" (p. 72). Since the head is an epidermal product it represents a trichome, while the stalk, being derived from both the protodermal and subprotodermal cells, constitutes an emergence.

It is obvious that in the examples described the trichome and emergence portions are clearly distinguishable from each other in the light of the ontogenetic and comparative morphological

from l.s. stem, *Xanthium strumarium*. Fig. 4. An emergence-based simple conical hair at maturity. Fig. 5. Early differentiation of the hair from protodermal cell. Fig. 6. Developmental stage of the subtending emergence. Figs. 7-8 from l.s. ovary, *Datura fastuosa*. Fig. 7. Initiation of the emergence involving both the protodermal and subprotodermal cells,  $\times 200$ . Fig. 8. T.s. emergence showing numerous vascular strands. Note that the vascular strands are associated with large amounts of sclerenchyma so that only on maceration the tracheary elements are revealed. Figs. 9-10. A simple conical hair and a stoma respectively from the surface of an emergence in *Momordica dioica*. Fig. 11. A diagrammatic representation of the vascular system of an emergence occurring on the pericarp of *Datura fastuosa*. Vascular system of the surrounding emergences is only partly represented. Note that the sclerenchyma associated with the vascular strands in the emergence becomes laterally coalescent forming into a cylinder towards the distal end of the emergence. (The vascular skeleton was isolated by putrefying a fruit and then washing away the softened tissue.) Figs. 12-15. from *Shepherdia canadensis*. Figs. 12-13. Differentiation of the shield. Fig. 14. A mature "peltate hair". Fig. 15. Developmental stage of the stalk of the peltate hair. Fig. 16. "Terminal gland" of a *Calycadenia* sp. Fig. 17. Stinging hair of *Urtica*. Figs. 12-15, after Cooper, 1932. Fig. 16, after Carlquist, 1959a. Fig. 17, after Eames and MacDaniels, 1947. The magnification of the figures reproduced is altered from that of the original ones. (t, trichome; e, emergence, v.b., vascular bundle; pt, protoderm; spt, subprotoderm; h, head; sh, shield; st, stalk.)

evidences. Hence, cases of this kind represent composite structures consisting of a trichome subtended by an emergence and not mere trichomes as has been generally interpreted.

The author's grateful thanks are due to Prof. M. R. Suxena, Head, Department of Botany, Osmania University, for his keen interest in the present work and for providing facilities.

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#### THE LAWS OF MASS ACTION—A CENTENARY VOLUME 1864–1964\*

THE Norwegian Academy of Science and Letters has brought out a noteworthy volume to mark the centenary of the Law of Mass Action. Of course, there is no meaning in assigning dates of birth to great scientific discoveries. Any new principle, law or effect that has undoubtedly taken a recognized place in science was seldom born all of a sudden. Rather, it has always been the result of a vague original conception successively clarified, tested and refined to a final precise formulation. Inevitably, the work of others who had preceded plays an important role. Thus the choice of the 11th March 1864 as the date of birth of the Law of Mass Action may seem arbitrary. But justification can be sought on the ground that it was on that date that Peter Waage presented before the Norwegian Academy of Science (then called Videnskabs-Selskabet i Christiania) a paper entitled *Studier Om Affiniteten* by Cato Maximilian Guldberg and Peter Waage, which, it may be said, contained the first satisfactory mathematical formulation of the condition for chemical equilibrium which finally led to the Law of Mass Action.

The effect of mass action on chemical reactions was first brought out clearly by L. Wilhelmy in 1850 in the course of a study of sucrose in the presence of acid. He showed that the rate of

the reaction at any instant was proportional to the amount of sucrose remaining unchanged at that instant. Later M. Berthelot and P. de Saint-Gilles (1862) who studied the reversible formation of ester from ethyl alcohol and acetic acid, found that the rate of reaction was approximately proportional to the concentrations of the reactants. This important result was generalised by Guldberg and Waage in a number of papers (1863–1869) and called the law of mass action. They named their first paper 'Studies on the Affinities'. In this and in the later ones they frequently speak of chemical forces and velocities of chemical reactions, and therefore they may be considered as the forerunners in what we now call chemical kinetics. Earlier and contemporary workers had experimented kinetics of chemical reactions but Guldberg (essentially a mathematician) and Waage (a chemist) were the first to propose a mathematical formulation which laid the foundation for this branch of chemistry.

The original paper of Guldberg and Waage, as presented at the Norwegian Academy on March 11th, 1864, is reproduced in this volume. It also contains a history of the discovery of the law and the biographies of the authors. There are contributory papers (not all of them related to the law of mass action) on topical subjects of interest from several physical chemists. Among the contributors are J. A. Christiansen, I. Prigogine, H. Eyring, Linus Pauling, D. C. Hodgkin and W. H. Zachariasen.

\* Published by Det Norske Videnskaps-Akademi i Oslo, pp. 194.

## LETTERS TO THE EDITOR

### C-GLYCOSIDES OF TAMARIND LEAVES

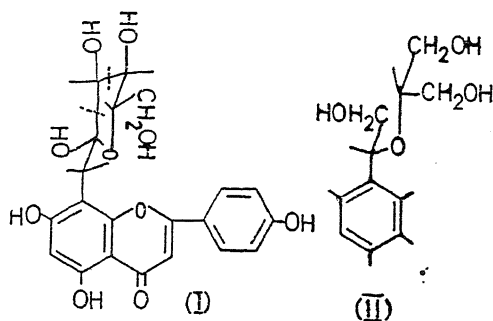
IN an earlier report on the anthoxanthin pigments of tamarind leaves, Lewis and Neelakantan<sup>1</sup> reported the presence of four glycosides (Rf 0.52, 0.68, 0.76 and 0.82) in the concentrated water extract of the leaves. They could not be identified because of their poor hydrolysability by acids. In a recent publication<sup>2</sup> they have identified the glycosides of Rf 0.52 and 0.68 to be lutexin and vitexin respectively. This prompts us to report our own results.

The pigments were first extracted from the fresh leaves with hot water; this solvent was unsatisfactory because only a fraction of the glycosides could be extracted by this means. In later experiments the extraction was done first with boiling alcohol followed by 80% and 60% alcohol. After removing the chlorophyll and waxy matter from the concentrated extract by extraction with petroleum ether and ether, the glycosides were extracted continuously with ethyl acetate, changing the solvent after every 24 hr. The first two fractions contained three pigments (Rf 0.52, 0.68 and 0.82) and on concentration deposited a solid containing two of them (Rf 0.52 and 0.68) along with a large amount of tartaric acid. Tartaric acid could be removed by dissolving the above mixture in the minimum quantity of water, neutralising with potassium bicarbonate and extracting the pigments with ethyl acetate. The next four fractions contained only two pigments (Rf 0.52 and 0.68) and the later fractions contained only one (Rf 0.68) which on concentration was deposited almost free from tartaric acid. On repeated crystallisation from pyridine-ether mixture pure yellow crystals were obtained, m.p. 252° (d),  $\lambda_{\text{max}}$ , 270, 334 m $\mu$ ; acetate, m.p., 257-58° and partial methyl ether, m.p. 264° (diazomethane method, purple colour with alcoholic ferric chloride). It was not hydrolysed by 7% aqueous sulphuric acid (24 hr.).

Fission of the glycoside with hydriodic acid in phenol gave the aglycone in almost quantitative yield. The ultra-violet spectrum of the aglycone ( $\lambda_{\text{max}}$ , 270 and 338 m $\mu$ ) underwent bathochromic shifts with sodium acetate, aluminium chloride and sodium ethoxide and no shift with boric acid-sodium acetate. This

suggested that it could be apigenin. The aglycone and an authentic sample of apigenin had the same chromatographic behaviour in four different solvent systems and the infra-red spectra resembled very closely. All the above properties and reactions showed that the glycoside was vitexin. Its ultra-violet and infra-red spectra and those of vitexin were superimposable; there was identity in chromatographic behaviour in four different solvent systems, and the mixed melting-point was undepressed.

That periodic acid oxidation of vitexin yields formic acid was first noted by Rao and Venkateswarlu<sup>3</sup> though the yield was low (0.64 to 0.82 mole). Later this was carried out by Horowitz and Gentili<sup>4</sup> using the trimethyl ether. It consumed two moles of periodate and yielded 1.03 moles of formic acid. Its formation suggested a pyranose structure for the sugar unit (see Formula I). NMR studies<sup>4</sup> on vitexin and its derivatives supported this formulation. In our present studies further confirmation has been obtained by subjecting the oxidation product (dialdehyde) to the action of sodium borohydride followed by hydrochloric acid, when glycerol is formed.



FIGS. 1-2

While discussing methods of distinguishing between O- and C-glucosides, Haynes<sup>5</sup> has contended that sodium periodate oxidation followed by sodium borohydride reduction and subsequent hydrolysis with dilute hydrochloric acid yields glycerol only in the case of O-glucosides whereas C-glucosides require ferric chloride treatment. This conclusion does not seem to be valid for all cases. We have examined authentic C-glucosides vitexin,

orientin, mangiferin and scoparin in the form of their methyl ethers. They yield glycerol on treatment of the periodate oxidised, borohydride reduced product with hydrochloric acid. In these particular cases this is not unexpected because as shown in formula (II) the concerned reduction product is a benzyl ether capable of hydrolysis with mineral acid to form glycerol. Actually in our experiments, each of these four samples was subjected to periodate oxidation (2 moles) for 4 hr. at room temperature, the dialdehyde reduced to the corresponding alcohol with sodium borohydride and the solution left overnight at room temperature. The reduced product on chromatography did not show the presence of glycerol. But when it was hydrolysed with N hydrochloric acid at 100° for 15 minutes, the presence of glycerol could be definitely detected by chromatography.

We are grateful to Prof. Hörhammer for kindly supplying authentic samples of vitexin, orientin and scoparin.

Department of Chemistry, V. K. BHATIA.  
University of Delhi, S. R. GUPTA.  
Delhi-6, September 4, 1964. T. R. SESHADRI.

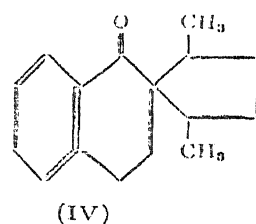
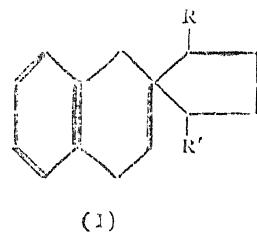
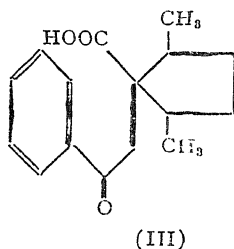
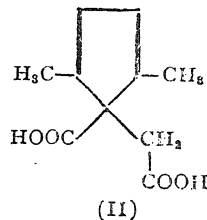
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#### SYNTHESIS AND REARRANGEMENT OF AN ALKYL DISUBSTITUTED SPIRANE

SPIRANES are known to undergo ring transformation on dehydrogenation with selenium.<sup>1,2</sup> Sengupta and Chatterjee<sup>3,4</sup> synthesised a number of spiranes of type I ( $R' = H$ ) and found that they smoothly rearrange on catalytic dehydrogenation to give an alkylated phenanthrene or a pyrene derivative depending upon the nature of the alkyl group and its position in the spirocyclopentane ring without any loss of carbon atom. With a view to study the rearrangement of spiranes with two alkyl substituents in the spirocyclopentane ring, the synthesis of 1,2,3,4-tetrahydronaphthalene-2,2-spiro-(2',5'-dimethylcyclopentane) (I,  $R = R' = Me$ ) was achieved by an extension of the method developed earlier<sup>4</sup> starting from the anhydride

of 2,5-dimethylcyclopentane-1-carboxy-1-acetic acid (II) and benzene.

The dicarboxylic acid (II) required for the synthesis was prepared from 2,5-dimethylcyclopentanone synthesised from 2-methyl-2-carboethoxy-cyclopentanone by opening up the ring with sodium ethoxide followed by Dieckmann cyclisation of the adipic ester, methylation and hydrolysis according to the procedure of Cornubert and Heiler.<sup>5</sup> Condensation of the ketone with ethyl cyanoacetate according to the Cope's method gave ethyl 2,5-dimethylcyclopentylidene cyanoacetate (82%), b.p., 95°–96° (0.5 mm.),  $n_D^{25}$  1.4822 which after potassium cyanide addition and hydrolysis furnished an isomeric mixture of the acid (II) from which non-resolvable meso acid, m.p. 173°–174°, anilic acid, m.p. 167°–168° and the resolvable racemic acid, m.p. 134°, anilic acid, m.p. 165° were separated.



The anhydride of the meso acid, b.p. 83°–84° (0.1 mm.), was condensed with benzene in the presence of anhydrous aluminium chloride in 80% yield to give meso  $\alpha\alpha$ -(2,5-dimethylcyclopentane)- $\beta$ -benzoyl propionic acid (III), m.p. 189°, methyl ester, m.p. 68°, which readily formed pyrilium salt showing the presence of a keto-methylene grouping. The keto-acid on catalytic reduction in a Paar apparatus at 60° in ethanolic solution gave meso  $\alpha\alpha$ -(2,5-dimethylcyclopentane)- $\gamma$ -phenylbutyric acid, m.p. 109–110° in 90% yield which was quantitatively cyclised by anhydrous hydrogen fluoride to give meso 1-keto-1,2,3,4-tetrahydronaphthalene-2,2-spiro-(2',5'-dimethylcyclopentane) (IV), m.p. 46°

which showed a strong I.R. peak at  $5.95\mu$ . Catalytic reduction of the spiro-ketone afforded the spiro-hydrocarbon (I,  $R = R' = Me$ ) in 85% yield, b.p.  $110^\circ$  (1 mm.),  $n_D^{25} 1.5315$ .

The anhydride of the racemic acid (II), b.p.  $100^\circ$ – $102^\circ$  (0.5 mm.) was similarly condensed with benzene to give the racemic keto acid (III), m.p.  $138^\circ$ , 2, 4-DNP derivative, m.p.  $242^\circ$ , which on catalytic reduction gave the corresponding racemic butyric acid as a thick colourless oil, b.p.  $162^\circ$  (0.3 mm.). This on cyclisation by anhydrous  $HF$  gave the racemic spiro-ketone (IV), m.p.  $30^\circ$  which on catalytic reduction afforded the racemic spirohydrocarbon (I,  $R = R' = Me$ ) in 65% yield, b.p.  $113^\circ$ – $115^\circ$  (1 mm.),  $n_D^{25} 1.5200$ .

Both these isomeric spiranes on dehydrogenation with 10% Pd-on-charcoal catalyst at  $320^\circ$  underwent smooth rearrangement without any loss of carbon atoms giving 1, 4-dimethylphenanthrene, m.p.  $49^\circ$ , although the racemic hydrocarbon was somewhat resistive to dehydrogenation.

Thanks are due to Prof. S. C. Shome for laboratory facilities.

Department of Chemistry, D. N. CHATTERJEE.  
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#### THE TRITERPENOIDS OF *EUPHORBIA ANTIQUORUM* LINN.\*

UNDER a scheme of chemical examination of *Euphorbia* species, the stems and the latex of *E. antiquorum* Linn. were examined for their crystalline principles. The stems (300 g.) were successively extracted with petroleum ether (B.P.  $40$ – $60^\circ$ ), ether and alcohol. The light yellow petroleum ether extract could be fractionated by crystallisation into three fractions, A, B and C. The alcoholic and ether extracts did not give rise to any crystalline compounds.

Fraction B (1.5 g.) crystallised from chloroform-methanol (once), and benzene (twice), when it came out as colourless needles, m.p.  $275$ – $77^\circ$ ,  $(\alpha)_D^{25} \pm 2^\circ$  (c, 1.2 in  $CHCl_3$ ) (Found: C, 84.35; H, 11.6;  $C_{30}H_{50}O$  requires C, 84.50;

H, 11.74%). It could be further purified by preparing a benzoate and hydrolysing it later with alcoholic alkali. The pure compound crystallised from benzene as colourless needles, m.p.  $277$ – $78^\circ$  having identical I.R. spectrum with taraxerol.<sup>1</sup> The acetate and benzoate also agreed in every respect with the description given for taraxeryl acetate and taraxeryl benzoate in literature.<sup>2</sup>

Fraction C (300 mg.) readily crystallises from chloroform-methanol (twice) as colourless needles, m.p.  $237$ – $38^\circ$ ,  $(\alpha)_D^{25} + 10^\circ$  (c, 0.98 in  $CHCl_3$ ). (Found: C, 84.55; H, 11.40;  $C_{30}H_{48}O$  requires C, 84.89; H, 11.32%.) This compound is different from taraxerol as it answers Zimmermann's test (intense purple) and like taraxerol gives yellow colour with tetra nitro methane (I.R.  $1705\text{ cm}^{-1}$  for carbonyl and  $814\text{ cm}^{-1}$ ). It gave rise to an oxime with hydroxylamine hydrochloride in pyridine, m.p.  $291$ – $93^\circ$ . It further undergoes reduction with sodium borohydride to give two fractions I—taraxerol,<sup>2</sup> m.p.  $274$ – $77^\circ$ , and II—iso-taraxerol,<sup>3</sup> m.p.  $266$ – $68^\circ$  separated by chromatography on alumina. The first fraction, taraxerol, is eluted completely with petroleum ether benzene (1:1) and the second fraction by benzene. These reactions identified the compound C as taraxerone,<sup>4</sup> formerly obtained by chromic acid oxidation of taraxerol.

Fraction A (800 mg.) of the petroleum ether extract was crystallised several times from chloroform-methanol, and benzene. But, no close melting fraction was secured. Separation was attempted through acetylation and benzylation. The acetate mixture also proved difficult for separation. But the benzoates readily crystallised into two fractions from chloroform-methanol; I—colourless needles, m.p.  $247$ – $48^\circ$ , and II—colourless prisms, m.p.  $214$ – $15^\circ$  later raised to  $252$ – $54^\circ$  by two crystallisations from chloroform-methanol. Compound I was debenzoylated by alcoholic alkali and crystallised from benzene to give colourless short needles, m.p.  $300$ – $01^\circ$ ,  $(\alpha)_D^{25} + 60^\circ$  (Found: C, 84.20; H, 12.43;  $C_{30}H_{52}O$  requires C, 84.12; H, 12.15%), identical with friedelan-3  $\alpha$ -ol<sup>5,6</sup> as it gives the acetate, m.p.  $310$ – $12^\circ$  and by chromic acid oxidation, friedelin,<sup>7</sup> m.p. and m.m.p.  $260$ – $62^\circ$  with an authentic sample.

Compound II is debenzoylated with alcoholic alkali to give friedelan 3  $\beta$ -ol,<sup>6</sup> m.p.  $288$ – $89^\circ$ ,  $(\alpha)_D^{25} + 14^\circ$  (Found: C, 84.3; H, 11.9;  $C_{30}H_{52}O$  requires C, 84.12; H, 12.15%), acetate  $293$ – $95^\circ$ ,  $(\alpha)_D^{25} + 26^\circ$  and it could be oxidised by chromic

acid to friedelin, m.p. and m.m.p. 260–62°, with an authentic sample. The ketone obtained above by chromic acid oxidation was reconverted into friedelan 3  $\beta$ -ol by sodium borohydride reduction.

The foregoing account clearly shows that the stems could be best extracted with petroleum ether and the triterpenoid fraction contained taraxerol, taraxerone, friedelan 3  $\alpha$ -ol and friedelan 3  $\beta$ -ol.

The latex (100 g.) from *E. antiquorum* Linn., collected by a Calcutta firm, was also examined systematically. It was coagulated by alcohol, and the hard coagulum was Soxhleted with petroleum ether (B.P. 40–60°) for 24 hr. The petroleum ether-soluble fractions were chromatographed on alumina column using petroleum ether, petroleum ether-benzene (1 : 1) and benzene-methanol (4 : 1). Thirty fractions were collected which by examination of their melting points could be separated into two fractions. I—(2 g.), m.p. 215–16°, and II—(1 g.), m.p. 116–17°. The later compound crystallised from methanol as colourless needles, 116–17°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 32°, (c, 1.1 in CHCl<sub>3</sub>). (Found: C, 84.51; H, 11.70; C<sub>30</sub>H<sub>50</sub>O requires C, 84.5; H, 11.74%), acetate m.p. 107–09°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 41° (c, 0.98 in CHCl<sub>3</sub>), benzoate m.p. 188–40°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 59° (c, 1.12 in pyridine). It is identical with authentic euphol isolated from *E. nerifolia*<sup>8</sup> and *E. tirucalli*<sup>9</sup> in these laboratories.

Fraction I crystallised from acetone-methanol as colourless short needles, m.p. 215–16°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 26° (c, 0.99 in CHCl<sub>3</sub>). (Found: C, 81.75; H, 11.22; C<sub>30</sub>H<sub>50</sub>O<sub>2</sub> requires C, 81.45; H, 11.32%). Acetate, m.p. 215–17°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 40° (c, 1.2 in CHCl<sub>3</sub>). (Found: C, 77.90; H, 10.20; C<sub>34</sub>H<sub>54</sub>O<sub>4</sub> requires C, 77.57; H, 10.27%), benzoate m.p. 214–16°, ( $\alpha$ )<sub>D</sub><sup>30°</sup> + 83.24° (c, 1.2 in CHCl<sub>3</sub>) (Found: C, 81.55; H, 8.72; C<sub>44</sub>H<sub>58</sub>O<sub>4</sub> requires C, 81.23; H, 8.92%). epoxide of the acetate, m.p. 205–07° (Found: C, 75.00; H, 9.73; C<sub>34</sub>H<sub>54</sub>O<sub>5</sub> requires C, 75.27; H, 9.96%). Further examination is under progress.

Our thanks are due to Professor Robert Stevenson, Brandeis University (U.S.A.), for a sample of friedelin, the Council of Scientific and Industrial Research for the award of a Junior Research Fellowship to V. A. and to Sri. P. R. Ramakrishnan, Principal, Coimbatore Institute of Technology, Coimbatore, for granting study leave and permission to conduct research at Andhra University, Waltair, to D.N.R.

Dept. of Chemistry,  
Andhra University,  
Waltair, August 11 1964.

V. ANJANEYULU.  
D. NAGESWARA RAO.  
L. RAMACHANDRA ROW.

\* This is a preliminary publication prompted by a short note by Sen Gupta, G. and Ghosh, S., *Indian J. Chem.*, 1964, 2, 298, who reported the isolation of epifriedelanol and taraxerol only from the stem bark of *E. antiquorum*.

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## FREE ORGANIC ACIDS IN SOME XEROPHYTES

CONSIDERABLE work has been done on the organic acids in plants.<sup>1,2</sup> Joshi<sup>3</sup> and Dabholkar<sup>4</sup> studied the organic acids in nitrophyllous and calcicolous plants of Bombay and found that the organic acid patterns of these plants are formed by citric, malic, malonic, succinic, glycollic and fumaric acids. Further, their investigations showed that the dominant nitrophyllous and calcicolous plants from the various associations contain the highest number of the acids.

The present paper reports studies on organic acids on five succulent xerophytes. The xerophytes, which are a distinct ecological group, have been selected for the present study to observe the organic acid metabolism in these plants and to see whether these plants have got a common pattern of organic acid production. In this account only the results on the free acids of these different plants have been presented and discussed.

The methods followed in extraction and chromatographic analysis are those of Dabholkar, Joshi and Bharucha. The chromatograms were developed with butanol : acetic acid : water and were sprayed with Indo-Phenol dye.

The results are presented in Table I.

These plants were in the flowering condition and it has been shown that succinic acid is found in the plant during this period only.<sup>5,6</sup> The absence, generally of tartaric and fumaric acids and sometimes citric acid, shows that the acid is not present in the free state but perhaps

TABLE I

Free organic acid patterns in xerophytes

Name of the plant	Family	Part of the plant	T	C	M	S	F
1. <i>Euphorbia tirucalli</i> (Linn.)	Euphorbiaceae	Stem	-	-	+	+	-
2. <i>Euphorbia anti-quorum</i> (Linn.)	"	Leaf	-	+	+	-	+
3. <i>Opuntia dillenii</i> (Haw.)	Cactaceae	Stem	-	+	+	+	-
4. <i>Marsdenia Volubilis</i> (Cooke)	Asclepiadaceae	"	-	-	+	+	-
5. <i>Sarcostemma brevistigma</i> (Wight & Arn.)	"	Leaves	-	-	+	+	-
		Stem	-	-	-	+	-

Where +, Present; -, Absent; T, Tartaric acid; C, Citric acid; M, Malic acid; S, Succinic acid; F, Fumaric acid.

is associated with the inorganic cations to form salts, or has been converted into some other acid in the Kreb's Cycle which is working in the plant.

The results also show that the plant families under study, viz., Euphorbiaceae, Cactaceae and Asclepiadaceae, which include some succulent plants, contain the acids of the malic acid group, indicating thereby that these plants may have the same type of organic acid metabolism, that is, the typical Crassulacean metabolism.

The author's thanks are due to Dr. B. R. Dhekney, former Principal of Rajaram College, Kolhapur, for facilities and to Dr. M. V. Dabholkar, Gopal Krishna Gokhale College, Kolhapur, for his guidance.

College of Science, SMT. L. S. HAJARNAVIS.  
Nagpur, July 14, 1964.

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#### ALKALOIDAL CONSTITUENTS OF *SENECIO CHRYSANTHEMOIDES*

The plant *Senecio chrysanthemoides* grows wild in Keshmir valley at altitudes of 8,000 to 11,000 ft. and is reported to produce poisoning in cattle. No chemical investigation of the plant appears to have been done. We studied this plant and isolated alkaloid seneciphylline in 0.01% yield from the roots.

Ten kilograms of the dry powdered roots were percolated in the cold with alcohol, solvent removed under reduced pressure and the total alkaloids obtained by the method of Watt.<sup>1</sup> These were chromatographed over deactivated alumina using benzene, chloroform and methanol as eluants. The benzene eluate on concentration gave a crystalline alkaloid while chloroform and methanol eluates failed to give any solid product. The alkaloid on repeated crystallisation from methanol gave alkaloid m.p. 213-16° (decom.) yield one gram. It showed ( $\alpha$ ), -118° (chloroform). It is homogeneous and gave single spot on Whatmann No. 1 paper in butanol, 5% acetic acid (1:1) system Rf. value (0.65). It gave picrolinate m.p. 192-93° (decom.), auric chloride m.p. (163-64). It gave C, 65.05%, H, 7.36%, N, 4.26%; calculated for  $C_{18}H_{23}NO_5$ , C, 64.67%, H, 7.18% and N, 4.19%.

I.R. Spectrum in KBr showed characteristic bands at 3424  $\text{cm}^{-1}$  (OH), 1739  $\text{cm}^{-1}$  (ester), 1716  $\text{cm}^{-1}$  (Co), 1640  $\text{cm}^{-1}$  C=C stretch and strong bands at 1443  $\text{cm}^{-1}$ , 1225  $\text{cm}^{-1}$ , 1150  $\text{cm}^{-1}$ .

Mixed m.p. determination with an authentic sample of Seneciphylline gave no depression and both showed the same Rf. values in thin layer and paper chromatography.

We are very grateful to Dr. C. K. Atal for sparing authentic sample of Seneciphylline and to Dr. L. D. Kapoor for procuring the material for work.

Regional Research Laboratory, B. K. WALI.  
Jammu, July 6, 1964. K. L. HANDA.

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#### THE EFFECT OF *ABRUS* *PRECATORIUS* ON PREGNANCY OF MICE

*Abrus precatorius* (Syn.: *Jequirity*) is a perennial twinner belonging to the N.O. Leguminosae. The seeds of *A. precatorius* are known to be toxic and to induce abortion when administered parenterally to pregnant animals.<sup>1-3</sup> The seeds are also claimed to act as antifertility agents.<sup>4</sup> Some aspects of our studies on the effect of the aqueous extract of these seeds on pregnancy in mice is reported in this communication.

Commercially obtained seeds of *A. precatorius* (scarlet variety) were used in these studies. The entire seeds were crushed, soaked in distilled water and macerated in the cold, and kept overnight for extraction. The material was then centrifuged and the supernatant obtained, kept in frigidaire. The extractions

were done quantitatively and the concentration used is expressed on the weight basis of the crude seeds taken.

The acute toxicity of the extract was determined. Subcutaneously  $LD_{100}$  was found to be 2 mg./kg. and 0.5 mg./kg. was non-toxic; orally 10 mg./kg. was not fatal while 25 mg./kg. caused death in 40% of the animals.

The drugs were administered to female mice at varying doses through different routes, prior to and during the period of pregnancy. Experimental details are shown in Table I.

TABLE I  
Influence of *Abrus precatorius* on pregnancy

Dose	Route	Details of administration	No. of animals used		Observation
			No. pregnant	Litter size	
0.5 mg./kg.	Subcutaneous	Single dose prior to mating	10/10	5.3	Vaginal haemorrhage and resorptions seen.
0.1 "	"	Daily during first five days of mating	10/10	6.7	Effects same as above but less severe
25 "	Oral	Single dose prior to mating	10*/6	..	Effects as above but inconsistent
10 "	"	"	10/10	7.5	Normal
Saline "	"	"	10/10	8.0	"

\*4 animals died within 4 days. The rest 6 showed pregnancy.

Salient features observed were: 0.5 mg./kg. subcutaneously given as a single dose prior to the mating did not prevent conception but adversely affected the foetal development. Vaginal haemorrhage—indicating the death of the foetus—during the second week of pregnancy was seen in some of the animals. In animals which littered, the litters were born dead or died within few hours after delivery. The size of the litters was comparatively small. In few animals the resorptions were complete and animals had regained their normal weight.

The experimental animals were opened after littering or after vaginal haemorrhage or after all the normal untreated mice had littered and the uterus was examined for normal foetuses, resorption, implantation sites and condition of the placenta. An empty uterus with occasional foetal and placental remains, complete resorptions with only implantation sites and foetuses in advanced stages of resorption were observed. The placenta of the foetuses found dead showed minute to large haemorrhagic areas visible macroscopically. Interspersed with these affected foetuses were also few normal ones—the number of young litters born were definitely smaller. Malformation of the foetus, like absence of lower limbs and anterior abdominal wall were also occasionally seen (Fig. 1, a, b).

The effect of 0.1 mg./kg. of the extract given daily, subcutaneously, during first five days of mating were similar to those observed with 0.5 mg./kg. subcutaneous but less severe in effect. Fifty per cent. of the animals littered normally but there appeared to be a delay of more than 15 to 20 days in the time of littering since mating, indicating probably the adverse influence of the drug on ovulation or fertilization during the early period of oestration.

The abrus seed extracts given orally exhibited a similar trend but results were

inconsistent. 25 mg./kg. given orally, as a single dose prior to mating, proved to be toxic to about 40% of the animals, causing death within four days. Amongst others which survived conception did take place. Complete resorption of foetuses, vaginal haemorrhage, delay in littering and completely normal litters were all observed to varying degrees.

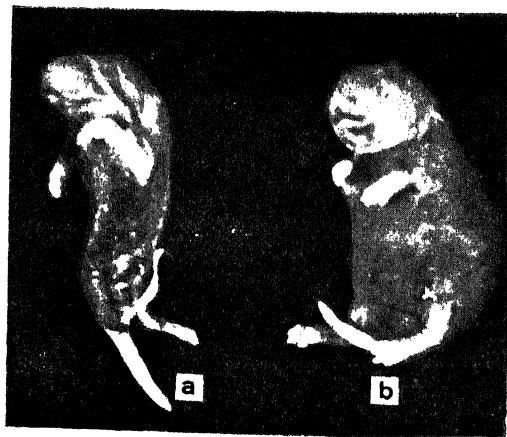


FIG. 1. Rat foetus. (a) Absence of one lower limb and non-fusion of the anterior abdominal wall. Aqueous extract of *A. precatorius* 0.5 mg./kg. S.C. given prior to mating. (b) Normal foetus.



It thus appears that abrus seeds contain toxic principles which adversely influence pregnancy and development of foetus. Their isolation and loci of action, whether on the placenta or on the foetus and other effects on reproductive physiology are under investigation.

Pharmacology Laboratory, V. B. DESAI.  
Indian Institute of Science, M. SINGH.  
Bangalore-12, August 4, 1964.

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## DIFFERENTIAL THERMAL ANALYSIS OF BRAZILIAN MINERALS

### IV. Pinguite

PINGUITE, a variety of chloropal, was reported by Bhaskara Rao (1960 a) from the Brejui Mine, near Currais Novos town in the Rio Grande do Norte State. In another paper (1960 b) further data on the mineral including the dehydration characters are given establishing the mineral as a separate species, and similar to nontronite.

The same samples are studied by the differential thermal method using an Eberbach Portable DTA set with the heating rate controlled to a 20° C./min. (Bhaskara Rao and Cunha e Silva, 1961 a). The results are tabulated below together with data on montmorillonite (Bhaskara Rao, 1961 b), obtained by the same apparatus, and nontronite (Vatan, 1954).

TABLE I

Species with localities	Peak temperatures in ° C.		
	Endothermic	Exothermic	
1. Pinguite, Brejui Mine, Currais Novos, RGN	140 st	200 w	960 (?) vw
2. Pinguite, <i>idem</i> .	150 st	210 w	490 w (I.)
3. Nontronite (feriferé), Manito	150 st	190 w	490 w (L.)
4. Montmorillonite, Barra Verde, Currais Novos, RGN	140 st	200 w	560 w-m
5. Montmorillonite, <i>idem</i> .	140 st	.. w	560 ..
6. Montmorillonite, Sta. Rita, New Mexico	150 st	190 w	640 m

st, strong; m, medium; w, weak; L, large (Intensities).

Such similarities are observed between the three minerals that distinction is difficult by d.t.a. study. The endothermic reactions can be explained in general lines as due to the loss of absorbed water, loss of water of crystallization and break of structure. The exothermic reaction in pinguite and nontronite is indicative of oxidation of the available ferrous iron, though it should be hematite with silica (tridimite?) as the final product.

Pinguite thus is very similar to nontronite, which in turn belongs distinctly to the smectite group of minerals, related to montmorillonites, and not chlorite (Hey, 1955).

The help of Mr. Judson da Cunha e Silva is acknowledged.

Escola de Geologia, A. BHASKARA RAO.  
Universidade do Recife,  
Recife, Brazil, June 22, 1964.

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## DECCAN TRAP FLOWS AT SAUGOR (M.P.)

In a recent paper dealing with the probable source of Deccan Trap lavas West<sup>1</sup> has dealt with the long distances which the lava flows appear to have travelled in Saugor area; and considering that over much of the trappean country dykes which may have been the feeders of these trappean flows are absent, he finds himself driven to conclude like the early workers that the Deccan Trap lavas have their source along the two regions—(i) the north-south belt along the west coast of India, and (ii) east-west belt along the Narbada Tapti valleys, where such dykes do occur.

Some of the workers in Deccan Trap area may not be inclined to accept such a statement as quite correct. This aspect of the problem needs extensive observations across the vast Deccan Trap country for locating the dykes which could be considered as the probable feeders of the lava flows. There is, however, a related matter, namely the occurrence of the Trap flows near

Saugor (M.P.) on which Dr. West has expressed opinions, which is the subject-matter of this note.

Most of the Saugor town is built on the Vindhya at an altitude of about 1,700 ft. to 1,750 ft. The Saugor lake is on the Vindhya. Some of the low-lying areas in the town, e.g., the Katra and a few others are at about 1,700 ft. or less. All the wells in the town are in the Vindhya and some of them are quite deep (50 ft. or even more). A few hillocks, e.g., the Shanichari Tori to the north-east of the lake, the Purbiau Tori to the west of the lake, and the hillock to the north-east of the railway station, which occur within the Saugor Town, are located on the Vindhya at altitudes of 1,780 ft. to 1,830 ft. The road running past the Tahsil Office, towards the village Tili is close to the Vindhya-Deccan Trap contact at an altitude of about 1,750 ft. to 1,780 ft. Vindhya are exposed to about 1,775 ft. in the Patharia village south of Saugor University hill. But the Saugor University Campus, the Civil Lines, District Court and Circuit House and the Cantonment area lying east and north-east of that are on the Deccan Trap, mostly above 1,750 ft.

In the Ganeshganj area, nearly 20 miles east of Saugor, the Vindhya occur at an altitude of 1,350 ft., and are succeeded by approximately 75 ft. of Lametas. The lowest of the trappean flows (No. 1 flow of West) in this area has its base at about 1,425 ft., and the top of the youngest flow (No. 3 of West) at an altitude of approximately 1,600 ft. The next younger six or seven flows, present at and around Saugor town (West, p. 48), occur at altitudes of 1,750 ft. and above. It is thus obvious that at and immediately around Saugor the Vindhya reach an altitude of 1,750 ft. to 1,775 ft., while the trappean flows (Nos. 5 to 10 of West) come above that level.

Referring to the great lateral extent of the lowest of the lava flows exposed in the Ganeshganj area, West (p. 48) says: "...It is not seen at Sagar itself, because it is buried beneath the later flows; but there can be no doubt that it continues beneath the town."

Trappean flows of Ganeshganj area, as pointed out above, occur at an altitude much lower than that at Saugor. It would appear that these trappean flows occurring in Ganeshganj area are, in stratigraphic sequence, lower than those occurring at Saugor itself. But when we consider the details given above it is obvious that the lowest of the Ganeshganj flows (No. 1 of West) cannot be expected to occur beneath the higher flows (Nos. 5 to 10 of West) at Saugor. Thus

what we get at Saugor are just those trappean flows which West has numbered 5 to 10 and none below them.

Bhonde Colony, G. W. CHITLONKAR.  
Karve Road, Poona-4, August 27, 1964.

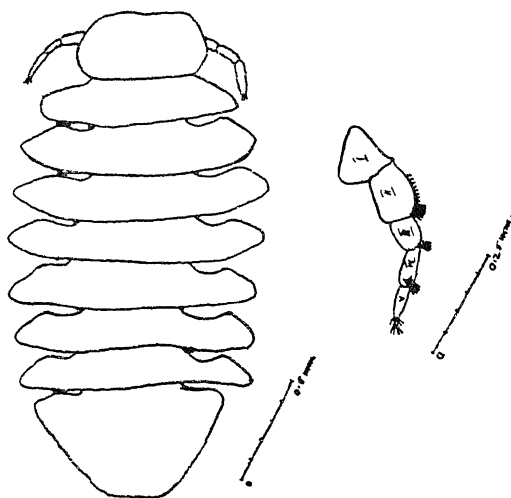
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#### A NOTE ON *STEGOALPHEON KEMPI* CHOPRA

CHOPRA (1923)<sup>1</sup> described a new branchiobopyrid parasite from specimens resembling *Alpheus crassimanus* Heller, which he named as *Stegoalpheon kempi* creating a new genus *Stegoalpheon*. Subsequently Krishna Pillai (1954)<sup>2</sup> described another new species from the branchial cavity of a crab and named as *Stegoalpheon choprai*. Shino (1951)<sup>3</sup> reported the occurrence of *Stegoalpheon kempi* from the branchial cavity of *Arcania* of Japanese waters.

The present note relates to the specimens of *Stegoalpheon kempi* found infecting the branchial cavity of *Alpheus malabaricus* Fabricius collected from Vellar estuary. This is the first record of this parasite from *Alpheus malabaricus* Fabricius.

The occurrence of this parasite on different hosts indicates that it is not specific to *Alpheus crassimanus* alone. From what is known so far it would appear that the distribution of the parasite is restricted to Indian and Japanese coasts.



FIGS. 1-2. *Stegoalpheon kempi* Chopra. Fig. 1. Entire male. Fig. 2. Antenna of the male.

Chopra (1923)<sup>1</sup> examined only one specimen and found it to infect the left branchial cavity. In the present study seven specimens were examined and six were found to be infected on the left side while one was infected on the right side.

The female specimens in the present collection agree with the description given by Chopra (1923),<sup>1</sup> but the males were found to differ considerably (Fig. 1). The male is short and thick, being about 2.1 mm. long, and with a maximum width of 1.05 mm. in the middle. The male described by Chopra (1923)<sup>1</sup> is 1.6 mm. in length and less than 1 mm. in width. It lies across the abdomen of the female from side to side and is not covered over by the pleopods.

Male specimen described by Chopra (1923)	Male specimen described here
1. The sides are parallel	The body is fusiform in shape
2. Basal segment of the antenna is the largest one	Second segment of the antenna is the largest one (Fig. 2)
3. Thoracic segments are rounded laterally	Thoracic segments taper considerably towards the sides
4. A prominent dark spot is present on the abdomen	No prominent dark spot is found
5. ..	The claw of the second thoracic leg is slightly larger than the claws of the other five thoracic legs; first claw the largest one

The infected specimens of *Alpheus malabaricus* when freshly collected were yellowish-green, while the normal ones were pale brown. They were kept alive for 15 days in the laboratory. The infected branchial chambers were at first light green in colour. But later they turned to straw yellow and finally became orange. This orange colour was found to be due to the enormous number of mature eggs. Later the eggs were shed separately but not in groups or as strings into water. Attempts to rear the eggs were not successful.

Grateful acknowledgment is made to Prof. R. V. Seshaiya for instruction and guidance, to Mr. K. Balasubrahmanyam for his help and to the University Grants Commission and the Ministry of Education for the award of research scholarships to us.

K. S. P. BHUSHANA RAO.  
T. N. C. RAMAPRASAD.

Marine Biological Station,  
Porto Novo (S.A. Dt.),  
July 27, 1964.

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### OCCURRENCE OF *RAUVOLFIA* *TETRAPHYLLA* L. IN PONDICHERRY

DURING a phytosociological survey of the Pondicherry territory, the author has come across this species so much reputed in pharmacology. Because of its economic importance a short account of its habitat is given here.

*Rauvolfia tetraphylla* (Syn. *R. canescens*) in Pondicherry occurs in the zone of sandy-loamy alluvial soil with water-table near the surface. Therefore, this soil type comes under the category "hydromorphic". This zone is planted with coconuts. Under the shade of coconuts, tapioca is commonly cultivated but the crop is not of good quality. *Rauvolfia*, on the other hand, does extremely well here, though only a few individuals are encountered. Some years ago this plant was abusively exploited from this area and is presently fast disappearing.

Native of West Indies, *Rauvolfia tetraphylla* is running wild, most probably as an escape from the gardens; however, it is naturalised only on this particular substratum (hydromorphic alluvium) in the Pondicherry region where a variety of soil types are to be found: saline, sandy, ferrallitic, ferruginous, black clayey, calcareous soils and various kinds of alluvia.

It is interesting to note that a special plant community corresponds to this alluvial-hydromorphic soil. The dominant species of the community is *Ruellia tuberosa* L. and the characteristic species are *Rauvolfia tetraphylla* L. and *Desmodium gangeticum* DC. Others of wider ecological amplitude which occur as companions in the community are:

*Achyranthes aspera* L., *Alysicarpus vaginalis* DC., *Chrysopogon aciculatus* (Retz.) Trin., *Croton bonplandianum* Baill., *Cynodon dactylon* Pers., *Desmodium triflorum* DC., *Euphorbia rosea* Retz., *Justicia prostrata* Gamb. and *Rhynchosia minima* DC.

Subba Rao<sup>1</sup> has described the occurrence of *R. canescens* in the Parlakimedi area of Ganjam

District. In this tract the annual rainfall is of the order of 1270 mm., number of rainy days are 67, the rainy season lasts from May to November. Mean annual temperature is about 27° C. and that of the coldest month January is 22.5°.

The climatic conditions of Pondicherry for the period 1914-60 may be summarised as follows: Annual average rainfall is 1250 mm., distributed over 50 days, mainly during July to December. The period February-May is very dry. Mean annual temperature is 28° C. and that of the coldest month January is 25°.

It is worthwhile mentioning that the hydro-morphic alluvium of Pondicherry, where the present land-use is unprofitable cultivation of tapioca of mediocre quality, may provide a suitable field for trials of cultivation of this valuable alkaloid-yielding species.

The data on the climate of Pondicherry, besides the site factor and the community in which *R. tetraphylla* occurs, are given so that its cultivation may also be tried out in other regions where analogous ecological conditions prevail.

The author is grateful to Dr. P. Legris, Director, Institut Francais, Pondicherry, for his keen interest and constant encouragement.

Institut Francais, V. M. MEHER-HOMJI.  
Pondicherry, August 1, 1964.

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### MEIOSIS IN *DERRIS FERRUGINEA* BENTH.

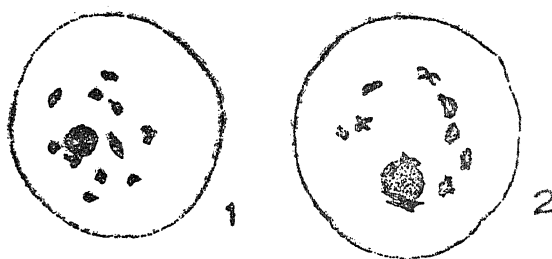
THE genus *Derris* includes over 50 species chiefly distributed in the Malayan archipelago. The best known species are *D. elliptica* and *D. malaccensis* whose roots constitute the Tuba Root of commerce used as insecticide and fish poison. It is extensively used in veterinary practice. The insecticidal properties depend on the presence of a group of compounds known as rotenoids of which rotenone, a crystalline ketonic compound, is the principal constituent. These two species are extensively grown in South-East Asia and parts of Africa.

*D. ferruginea* is a woody climber and grows wild in parts of India, notably Assam. This is the only source of the Indian Tuba Root. This species bears a close resemblance to *D. elliptica* but is distinguished from it by a rusty pubescence on the tender parts of the stem and the exudation of a watery sap from the older

parts. The rotenone content of *D. ferruginea* roots varies from 0.1 to 4.3% and other extrarotenes from 1.0 to 4.5%. A notable feature of this climber is the incredible rate of growth of the tendril. The auxin activity in the tendril tip in relation to the rate of growth is under study.

Materials for the present study were collected from the Forest Research Laboratory, Bangalore, where the plant was introduced more than twenty years back. The plant flowers freely in the months of January-March. Anthers were fixed in acetic-alcohol and squashed in acetocarmine.

Association at  $M_1$  is normal and eleven bivalents have been clearly observed (Fig. 1). Occasionally two homologues fail to pair and appear as univalents. Segregation at  $A_1$  and  $A_{11}$  is normal.



FIGS. 1-2. Fig. 1. P. m. c. showing eleven bivalents. Fig. 2. Diplotene-diakinesis showing two bivalents attached to the nucleolus.

Two bivalents are attached to the nucleolus indicating the polyploid nature of the species (Fig. 2). On the basis of chromosome number, in other species of *Derris*, it has been suggested that there are three basic numbers, in the genus, viz., X-11, X-12, X-13. The association of two bivalents with the nucleolus indicates that the haploid number 11 is itself derived from a smaller genome in the course of evolution. Further investigations to elucidate this aspect are under way.

We thank Dr. M. N. Ramaswamy for his interest in the work.

Central Indian Medicinal Plants Organisation, K. V. SRINATH.  
Bangalore, June 4, 1964. MOHAMED SARWAR.

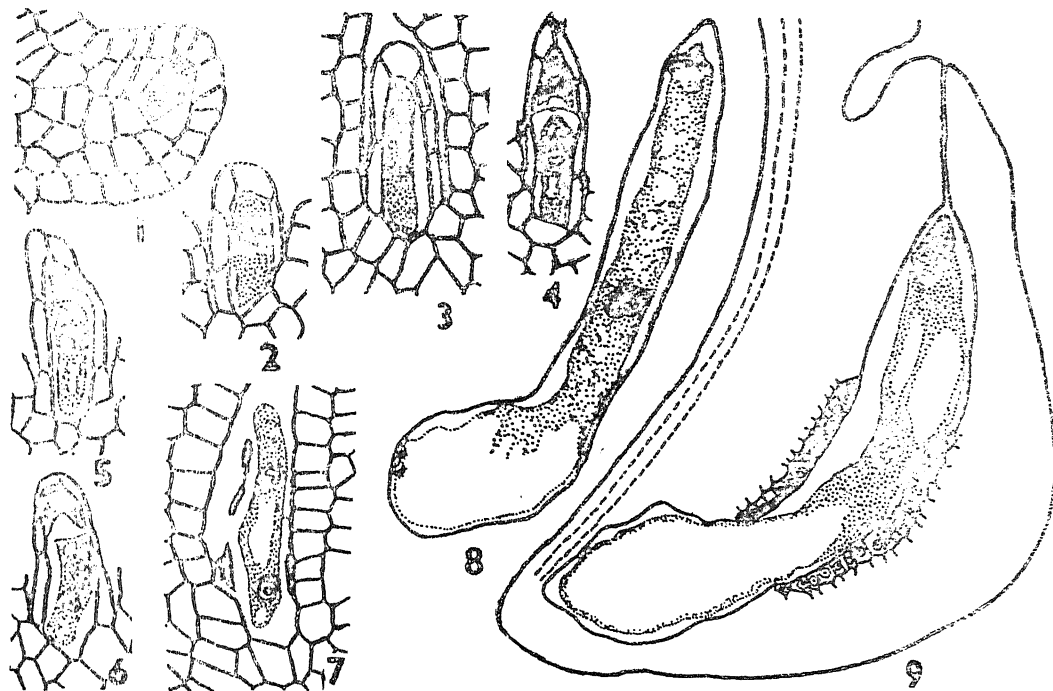
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# THE FEMALE GAMETOPHYTE OF *LINARIA RAMOSISSIMA* WALL.

The mode of embryo sac development in all the species of the tribe Antirrhineae (Scrophulariaceae) so far investigated has been found to be of the Polygonum type.<sup>1-4</sup> The present note deals with the development of the female gametophyte of *Linaria ramosissima*, a member of Antirrhineae and a common weed found on the fort walls and rock crevices in Chitradurga, Mysore State.

The ovary is superior, bicarpellary, syncarpous and bilocular. A large number of ovular primordia differentiate as blunt outgrowths from the young axile placenta and develop into tenuinucellate, integritic and anatropous ovules (Figs. 1, 9).

The micropylar dyad cell is comparatively smaller than the chalazal one. The former soon begins to degenerate while the latter enlarges further and its cytoplasm becomes vacuolate (Figs. 5, 11). The nucleus of the functional dyad cell divides and no wall is laid down after this division (Fig. 6). The two daughter nuclei move apart to opposite poles due to the organization of a central vacuole. The 2-nucleate embryo sac thus produced elongates further and the cells of the nucellar epidermis get crushed and their remnants absorbed along with degenerated dyad cell. As a result the sac comes in contact with the inner epidermis of the integument (Fig. 7). After a nuclear division in the 2-nucleate embryo sac a 4-nucleate sac is produced. By another nuclear division it gives

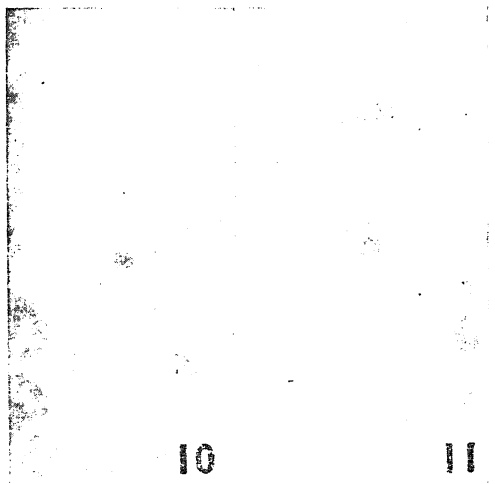


FIGS. 1-9. Fig. 1. Young ovular primordium with the archesporial cell,  $\times 900$ . Fig. 2. A megaspore mother cell,  $\times 900$ . Fig. 3. First nuclear division in the megaspore mother cell,  $\times 900$ . Fig. 4. The dyad cells,  $\times 900$ . Fig. 5. The dyad cells with the upper one degenerating,  $\times 900$ . Fig. 6. The functional dyad cell after a nuclear division,  $\times 900$ . Fig. 7. 2-nucleate embryo sac,  $\times 900$ . Fig. 8. 8-nucleate embryo sac,  $\times 630$ . Fig. 9. L.s. ovule at the mature embryo sac stage,  $\times 630$ .

A hypodermal archesporial cell becomes differentiated very early in the ovular primordium (Fig. 1). It enlarges and directly functions as the megaspore mother cell (Fig. 2). After the first nuclear division during meiosis in the megaspore mother cell a transverse wall is laid down producing two dyad cells (Figs. 3, 4, 10).

rise to an 8-nucleate embryo sac (Fig. 8). Of the four nuclei formed at the micropylar end two contribute to the organization of the synergids, one to the egg and the fourth functions as the micropylar polar. At the chalazal end three of the four nuclei produced degenerate and the fourth functions as the

chalazal polar. The two polars move towards each other, meet in the centre of the embryo sac and fuse together forming the secondary nucleus. The mature embryo sac is long, tubular and curved with a tapering micropylar part and a bulbous chalazal region which comes in contact with the conducting strand of the ovule. The egg apparatus consists of two elongated synergids and an egg. The secondary nucleus usually lies in the middle region of the embryo sac. The antipodals are ephemeral as in *Linaria vulgaris*<sup>2,4</sup> and *L. genistæfolia*.<sup>3</sup> An integumentary tapetum of densely cytoplasmic cells surrounds the embryo sac (Fig. 9).



FIGS. 10-11. Fig. 10. Photomicrograph of dyad cells,  $\times 1,800$ . Fig. 11. Photomicrograph showing the degenerated micropylar and the functional chalazal dyad cells,  $\times 1,800$ .

It is of great interest, therefore, to note that the development of the female gametophyte in *Linaria ramosissima* conforms to the *Allium* type and differs from the rest of the Antirrhineae so far studied. A detailed paper on the embryology of this species will be published elsewhere.

We are sincerely thankful to Professor M. Nagaraj for facilities and Mr. D. Ganesh for the photomicrographs.

Dept. of Botany, GOVINDAPPA D. AREKAL.  
Central College, Bangalore-1,  
and

Department of Botany, D. RAJU.  
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## MULTIPLE ALLELISM IN RADIATION-INDUCED RAY-FLORET MUTANTS OF ANNUAL CHRYSANTHEMUM

THE annual chrysanthemum, *Chrysanthemum carinatum*, is a popular ornamental plant grown for the "tricolour" appearance of its flower-heads composed of characteristic colour patterns of ray and disc florets. The present investigation was designed to induce variation in the flower form. Dry seeds were irradiated by X-rays with an acute dose of 15 Kr. at an operating voltage of 50 Kv. and an  $X_1$  population of 500 plants was grown. Keeping in view the highly heterozygous nature of the experimental material because of the self-incompatibility system, a large control population was raised each year for a critical comparison. Four mutant types affecting the ray-florets were obtained in the  $X_2$  population: one of these had dissected type rays in which the strap-shaped petals were split into two along their entire length, the second was of the tubular type in which the flat rays assumed the tubular appearance, the third ('nanny' type) was characterised by very small rays (about one-tenth of the normal size) while the fourth was the apetalous type in which the ray-florets were conspicuously lacking. It is interesting to note that all these four variants of the normal ray-floret phenotype have been observed in another member of Compositae, *Cosmos bipinnatus*, as expected on the basis of the law of homologous variation.<sup>1,2</sup> A tubular type mutant in annual chrysanthemum was also reported earlier from this laboratory by Jain *et al.*<sup>3</sup>

In order to ascertain the genetic nature of the induced change, all the mutant forms were crossed with the normal type and were also intercrossed among themselves. This recombination test revealed that all the four mutants differed from the normal type as well as from one another with respect to a single gene and all of them were recessive in inheritance to the normal phenotype. The fact that it has not been possible to recover the normal type through intercrossing of the various mutants suggests that all the four induced types are alternative forms of a single gene governing the ray-floret characteristics. Among the mutants, the dissected type is dominant over the other three, the tubular type is dominant over the nanny and the apetalous types while the apetalous type behaves as the bottom recessive.

Different alleles of a gene can be employed to test the current concepts of the physiology

of gene action. Certain chlorophyll allelic mutants of barley, for example, have been reported to act by way of causing genetic blocks in a chain of reactions in much the same manner as that reported for biochemical mutants of micro-organisms.<sup>4</sup> A series of alleles present at the same locus may also act by affecting one and the same reaction differently, for example, by changing the rate and (or) the quantity of the end product.<sup>5</sup> Different alleles of such a locus will then represent varying potencies of action. It seems likely that the action of the mutant alleles responsible for the dissected and the tubular types differs from that of the normal allele in a qualitative aspect while the mutants nanny and apetalous types are variants of the normal allele having low potencies of action so that a threshold needed for development of the normal phenotype is not reached. If it were possible to follow the primary gene product through its various stages of interaction with other compounds leading to development of the type effect, the physiological basis for inter-allelic differentiation could be better understood.

I am grateful to Dr. M. S. Swaminathan and Dr. H. K. Jain for their interest in the study.

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#### SOME RECORDS OF PLANT PARASITIC NEMATODES IN INDIA

IN a recent survey of the Horticultural Orchard at the Indian Agricultural Research Institute, New Delhi, as well as orchards in the Punjab, Assam, West Bengal, Rajasthan and Maharashtra, soil samples from the root zones of citrus trees, showing die-back symptoms, were collected and analysed by modified Baermann funnel method. The examination revealed the presence of large populations of larvae of *Tylenchulus semipenetrans* Cobb, 1913. The roots, when stained in cotton blue lacto-phenol, showed a large number of females of the nematode attached to them. Such roots were short and slightly thickened irregularly. The trees, showing the initial die-back symptoms, were supporting a heavy population of the larvae of the nematode (17,894 larvae per 200 g. soil

sample analysed) but the number of larvae around the root zones gradually decreased with the gradual drying of the trees. The other plant parasitic nematodes isolated from the root zones of such trees were species of *Hoplolaimus*, *Helicotylenchus*, *Rotylenchus*, *Pratylenchus*, *Tylenchorhynchus*, *Rotylenchulus*, *Paratylenchus*, *Hemicycliophora*, *Criconemoides*, *Xiphinema* and *Longidorus*. The populations, however, were very low.

In another survey the 'molya' disease of wheat and barley, caused by *Heterodera avenae* Wollenw., was found to be present in the Islampur village, District Mohindergarh, Punjab, about 100 miles south-west of Delhi bordering Rajasthan. So far this disease has been known to be present in Rajasthan only, particularly the eastern part. According to the statements of the cultivators the affected fields started showing patchy growth of wheat and barley about three years ago. This is the first record of this nematode outside Rajasthan.

The fruits and vegetable plots of Simla Hills were surveyed during May 1963. Besides several plant parasitic genera that were recorded from these soil samples, *Tylenchorhynchus capitatus* was of interest. This species was isolated from soil samples collected around Hollyhock, *Rubus ellipticus*, Apple, Plum and Strawberry in Simla Hills and Citrus from Assam area. In all these cases plant growth was very poor specially in Hollyhock where stunting was about 70% as compared with the normal plants.

From potato fields in Bekalhatti, Simla Hills, few cysts of *Heterodera carotae* were collected. Also from tomato fields of the Division of Horticulture, Indian Agricultural Research Institute, New Delhi, cysts of *Heterodera galeopsidis* were collected. These are new records for India.

The authors are indebted to Dr. B. L. Chona for going through the manuscript.

Division of Mycology and Gopal Swarup.  
Plant Pathology, C. L. SETHI.  
Indian Agric. Res. Inst., J. S. GILL.  
New Delhi, October 17, 1963.

#### SIDA OVATA FORSK.—A NEW RECORD FOR SOUTH INDIA

THE occurrence of *Sida ovata* Forsk. in Nagarjunakonda valley, Nalconda District, Andhra Pradesh, constitutes a new record for the whole of Southern India. It is an exotic plant from Arabia and tropical Africa which has so far been reported from Punjab (Hissar—Duthie),

Rajasthan (Jodhpur—Collector?; Marwar—King), Gujarat (Rajkot—Santapau; Dwarka, Okha, Chotila, Jamnagar—Santapau) and Kutch (Stoliczka) in India. The plant has recently been collected during a botanical exploration of the Nagarjunakonda valley in Andhra Pradesh. Since the Nagarjunakonda valley and its surroundings will be submerged under water as soon

and Rich, *Fl. Senegamb. Tent.*, 1831, 1, 71; Masters in *Fl. Brit. Ind.*, 1872, 1, 323; Cook, *Fl. Pres. Bomb.*, 1901, 1, 98.

The plant is an undershrub, with a thick root-stock and is one of the rare plants collected from the valley.

*Fruit.*—July.

*Andhra Pradesh.*—Nagarjunakonda valley, Nalconda District, 16-7-1961—*Thothathri* 9724 (Herb. CAL).

*Distribution.*—Punjab, Rajasthan, Gujarat, and Kutch. The plant grows profusely in Sind, Karachi and West Punjab in Pakistan.

My sincere thanks are due to Dr. H. Santapau, Director, Botanical Survey of India and Dr. S. K. Mukerjee, Keeper, Central National Herbarium, for encouragement.

Central National Herbarium, K. THOTHATHRI.  
P. O. Botanic Garden, Howrah,  
March 10, 1964.

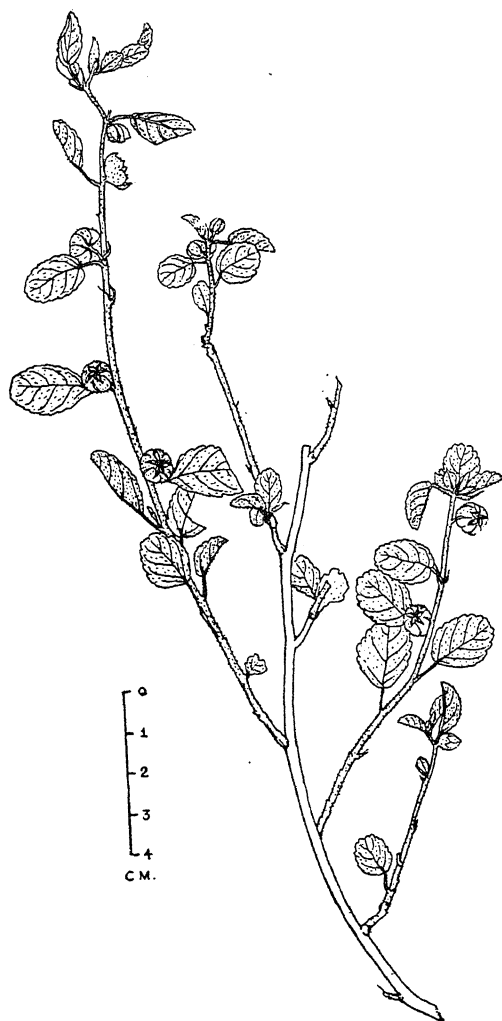


FIG. 1. *Sida ovata* Forsk.

as the Nagarjunakonda dam is completed, it is worthwhile to record here the occurrence of this interesting plant with an illustration.

The plant is usually known in our Indian zones as *Sida grewoides* and its correct nomenclature is as follows: *Sida ovata* Forsk. *Fl. Aeg. Ar.*, 1775, 124; Santapau in *Fl. Saur.*, 1962, 1, 36. *Sida grewoides* Guill. & Perr. in Guill. Perr.

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#### A NEW SPECIES OF *PESTALOTIOPSIS* ON THE LEAVES OF *QUERCUS* *INCANA* ROXB.

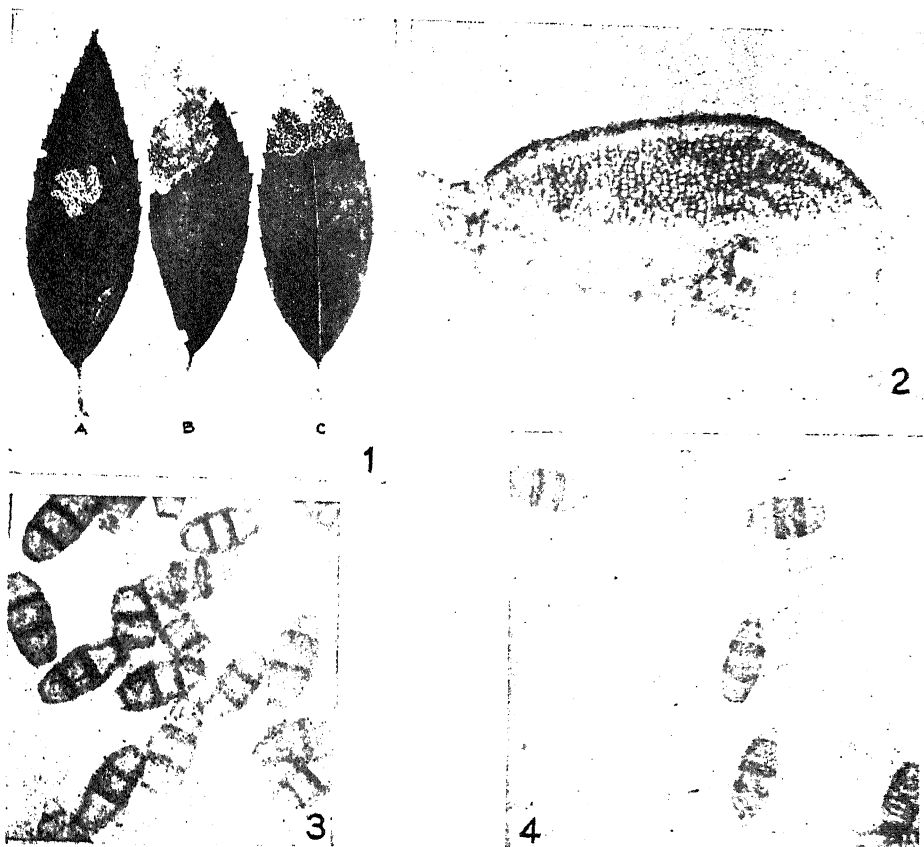
In September 1963, during a collection tour of leaf-spot fungi in Darjeeling area, the authors observed the leaves of *Q. incana* to be unsparingly infected. The spots were light brown or silvery gray with very profuse fructifications on the upper side. The infection usually started from the tips and gradually advanced towards the base (Fig. 1, B and C), sometimes irregular spots which were generally vein limited were produced in the centre (Fig. 1, A). Detachment of the diseased regions was the ultimate phase. Microtome sections through the fruiting bodies showed that acervulus was a well-developed dome-shaped structure filled up with numerous conidia of *Pestalotiopsis*. The specimen of the diseased leaves was sent to Commonwealth Mycological Institute, Kew, but it could not be assigned to any particular species of *Pestalotiopsis*.



Earlier Mundukur and Kheswalla (1942) had recorded *Pestalotia clavispora* Akt. (which has been redescribed as *Pestalotiopsis clavispora* by Steyaert) on the leaves of *Q. incana* at Mussoorie. The present species markedly differs from *P. clavispora* and characters on comparative basis are given in Table I.

Due to pronounced variations in shape, dimension and colour of conidia as well as number and length of setulæ, the present species is being designated as new species.

The detail morphological characters of the isolate are described as follows:



FIGS. 1-4. Fig. 1. Photograph of diseased leaves. Fig. 2. Microphotograph of section of the diseased leaf showing well-developed dome-shaped acervulus,  $\times 150$ . Fig. 3. Microphotograph of conidia,  $\times 525$ . Fig. 4. Microphotograph of conidia showing setulæ,  $\times 486$ .

TABLE I

Characters	Present isolate	<i>P. clavispora</i>
Length and shape of conidia	Clavate, $23.4-31.2 \mu$	Clavate fusiform, $18-26 \mu$
Breadth of conidia	$7.8-10.4 \mu$	$6.5-8.5 \mu$
Lower hyaline cell	Protrudes to a long filiform pedicel	Acute or conoid
Colour of the intermediate cells	Olive brown	Umber-fuliginous
Number and length of setulæ	Four to eight, never branched, $20.8-52 \mu$ long	Three or four, rarely branched, $17-31 \mu$ long

*Pestalotiopsis darjeelingensis*, SP. N.

Hyphe thin hyaline, richly branched  $1.3-3.9 \mu$  in width; conidia five-celled, clavate,  $23.4-31.2 \times 7.8-10.4 \mu$  (vide Fig. 3); three median cells olive brown; basal hyaline cell protrudes into a hyaline filiform pedicel measuring  $2.6-7.8 \mu$ , superior hyaline cell small and conic, bearing four (10%), five (20%), six (35%), seven (25%) or eight (10%) setulæ of varying length from  $20.8-52.0 \mu$  (vide Fig. 4); acervuli erumpent dome-shaped measuring  $218.5 \times 74.8 \mu$  to  $356.5 \times$



## REVIEWS

**Magnetism : A Treatise on Modern Theory and Materials** (Vol. I). Edited by George T. Rado and Harry Suhl. (Academic Press, Inc., 111, Fifth Avenue, New York-3, New York), 1963. Pp. xv + 688. Price \$ 19.00.

The general purpose of this treatise has already been quoted in the review of its third volume which appeared in *Current Science* issue of May 20, 1964, on page 318. The subtitle of the present volume indicates the topics dealt with; Magnetic Ions in Insulators, Their Interactions, Resonances and Optical Properties. The subject-matter is covered in twelve chapters, each written by a specialist or specialists in this field. They are listed below: (1) Spin Hamiltonians by K. W. H. Stevens; (2) Exchange in Insulators: Superexchange, Direct Exchange, and Double Exchange by P. W. Anderson; (3) Weak Ferromagnetism by Toru Moriya; (4) Anisotropy and Magnetostriction of Ferromagnetic and Antiferromagnetic Materials by Junjiro Kanamori; (5) Magnetic Annealing by John C. Slonczewski; (6) Optical Spectra in Magnetically Ordered Materials by Saturo Sugano and Yukito Tanabe; (7) Optical and Infra-red Properties of Magnetic Materials by Kenneth A. Wickersheim; (8) Spin Waves and Other Magnetic Modes by L. R. Walker; (9) Antiferromagnetic and Ferrimagnetic Resonance by Simon Foner; (10) Ferromagnetic Relaxation, and Resonance Line Widths by C. Warren Hass and Herbert B. Callen; (11) Ferromagnetic Resonance at High Power by Richard W. Damon; (12) Microwave Devices by Kenneth J. Button and Thomas S. Hartwick.

A perusal of the articles indicates that an attempt has been made to reach a high level of thoroughness and up-to-dateness, while retaining the maximum clarity of exposition. The article on Ferromagnetic Relaxation and Resonance Line Widths extends over a hundred pages, while the other articles are shorter, ranging between 20 and 60 pages each. A valuable feature of the book is the extensive list of references given at the end of each chapter, thereby enabling the interested reader to pursue in further detail any aspect of the subject in which he may feel specially interested.

C. V. R.

**Nuclear Orientation** (*International Science Review Series*, Vol. VI). Edited by M. E. Rose. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. 321. Price \$ 4.95.

The pioneering papers in rapidly developing fields of the physical sciences are selected from the world literature and brought together in the volumes of this continuing series. The present volume dealing with "Nuclear Orientation" contains a collection of some fifty papers. The first paper is a review article by E. Ambler and the remaining papers have been selected with a view to cover the following general areas: (1) Theoretical discussion of methods of nuclear orientation; (2) Observation and detection of nuclear orientation and (3) Applications of nuclear orientation. The entire volume is prefaced by an article by the editor, in which the whole subject is surveyed broadly and the reasons guiding the particular selection made from the extensive literature are also explained. The famous announcement by C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes and R. P. Hudson on "Experimental Test of Parity Conservation in Beta Decay" is reproduced on pages 232 and 233 of the volume under review. The great utility of such a collection to those interested in the field should be obvious and need scarcely be enlarged upon. C. V. R.

**Chemical Applications of Infrared Spectroscopy.**

By C. N. R. Rao. (Academic Press, 111, Fifth Avenue, New York 3, New York), Pp. xiii + 683. Price \$ 19.50.

This volume aims to present the basic concepts, measurements and techniques of infrared spectroscopy and to survey as completely as possible its chemical applications. The subject is handled in twelve chapters, viz., (I) Basic Concepts, Instrumentation, and Techniques, (II) Hydrocarbons, (III) Oxygenated Organic Compounds, (IV) Organic Nitrogen Compounds, (V) Organo Derivatives of Boron, Silicon, Phosphorus, Sulfur, Halogens, and other Elements, (VI) Heterocyclic Compounds, (VII) Inorganic Compounds, (VIII) Specific Applications in Organic Chemistry, (IX) Specific Applications in Biochemistry, (X) High Polymers, (XI) Quantitative Analysis and (XII) Miscellaneous Topics. Each chapter is accompanied by an extensive

bibliography. Numerous figures, tables and charts figure in the book. The author along with his collaborators has worked extensively in the field. It will be evident that in thus systematising the great accumulation of experimental facts of the subject, he has rendered very useful service to all investigators interested in infrared spectroscopy and its applications.

C. V. R.

**An Introduction to Crystal Chemistry** (Second Edition). By R. C. Evans. (Cambridge University Press, London, N.W. 1), 1963. Pp. xii + 410. Price 52 sh. 6 d.

The manner how atoms (or ions) build themselves into solid crystalline structures is intimately related to the nature of the forces which exist between them. Thus if the interatomic forces are known one can predict the structure of the crystal to be expected, and, conversely, if the structure is known the nature of these forces can be assessed. Four types of interatomic forces or bonds, essentially electronic in nature, have been recognized according to which crystals can be broadly classified with reference to their physical and structural properties. These interatomic bonds are the ionic bond, the covalent bond, the metallic bond and the Van der Waals bond.

Evans's book deals at an introductory level with these predominant types of binding forces and explains the fundamental principles of crystal architecture. Emphasis is on interpreting chemical and physical properties of crystalline substances in terms of their structures. Although recent advances in the experimental techniques of studying crystal structures have added largely to the number of known structures, requiring a reorientation of ideas, the book by Evans since it deals with the basic principles will continue to be in demand by students of crystal chemistry, as is evident from the issue of the second edition.

The first edition of the book was published in 1939. It had gone through three reprints up to 1952. The second edition is enlarged and rewritten and appears in a larger format with many of the diagrams specially redrawn. The first six chapters of 120 pages forming Part I of the book deals with the general principles of crystal structure. The next eight chapters forming Part II contain discussions of systematic crystal chemistry relating physical and chemical properties to the structures. The structures described have been reinterpreted in terms of more modern ideas of chemical bonding.

A. S. G.

**Advances in Biological and Medical Physics** (Vol. 9). Edited by T. L. Hayes, John H. Lawrence and John W. Gofman. (Academic Press, New York and London), 1963. Pp. ix + 496. Price \$ 16.00.

A glance through the seven stimulating articles in this latest issue on "Advances in Biological and Medical Physics" published under the auspices of the University of California, Berkeley, California, would convince anybody of the almost breath-taking pace with which physics and mathematics are making their impacts felt in modern medical and biological researches. For clearer understanding of newer problems that are constantly arising in the field of medicine and biology, modern research workers are tending more and more to introduce purely theoretical and mathematical concepts towards the explanation of many biological phenomena and are frequently adopting mathematical formulæ also for purposes of quantitative measurements, wherever possible. The goal of biological research today appears to be to discover, if possible, some physico-chemical laws which may explain the complex, underlying mechanisms and variations in biological processes in terms of more definite and definable mathematical language. In depth and importance of subject coverage and in the research status of its contributions, Volume 9 can be considered to be a very useful addition to this series.

The volume contains seven independent articles: (1) Some recent advances in studies of the transcription of the genetic message; (2) Human chromosomal aberration; (3) Tissue Transplantation; (4) The microbeam as a tool in Radiobiology; (5) Electron paramagnetic resonance studies of biological interest; (6) Polarimetric analysis of protein structure; and (7) The analysis of biological similarity. The subject-matter has been very ably dealt with and the most up-to-date data have been brought together with precision and a logical sequence. While it is difficult to single out any one particular presentation of well-known investigators for special mention, the reviewer found himself especially drawn to the sections on 'Microbeam in radiobiology', 'E.P.R. studies of biologic interest' and 'analysis of biological similarity'. All these areas have been fully and adequately covered and give rise to many challenging and provocative questions, in addition to answering many points of current research interest. The emerging subject of biomathematics is assuming greater importance in describing biological phenomena in mathematical measurements and

parameters. The future generation of biologists cannot also hope to escape the growing impact of mathematics, if they have to progress in the field of quantitative measurements of such phenomena as growth, hemodynamics, ergonomics, locomotion, generation, analysis of data from quantitative anatomy, velocity in nerve fibres, etc., etc.

The book will prove a very useful addition to the library of all research scientists in the field of medical and biological physics.

B. MUKERJI.

**Radiation Effects on Organic Materials.** Edited by R. O. Bell and J. G. Carroll. (Academic Press, New York and London), 1963. Pp. 576. Price \$ 13.50.

As the civilian use of nuclear power expands, so will the necessity to become familiar with the effect of radiation on materials. Radiation induced changes in properties are of importance to scientists and technologists entrusted with the task of selecting materials for use in the reactor and exposed to radiation. The present publication presents for the first time in a book form, a mass of available information on the effects of nuclear radiation on the properties of organic liquids, solids and gases.

Apart from the three introductory chapters on the interaction of radiation with matter, Mechanisms of chemical effects of ionizing radiation, and Radiation chemistry of pure compounds, there are separate chapters dealing with radiation induced changes in physical and chemical properties of Polymers, Plastics, Elastomeric Materials, Coolants, Lubricants, Adhesives, Textiles, Coating and Films, Dielectric Fluids, Fuel and Fluid Shield Materials, and Coal, Wood and Explosives. Each chapter has been written by active workers in their respective fields and contains exhaustive references to supplementary information.

Throughout the book, the unit used to express the absorbed dose is rad, and the reader can compare the data of various workers without going into the comparison of different dosimetric methods.

It would, however, be obvious to the reader, that in this rapidly advancing field, much remains to be done both from the theoretical and practical points of view, to improve our knowledge of the resistance of materials to radiation.

H. B. MATHUR.

**Survey of Progress in Chemistry (Vol. 1).**

Edited by A. F. Scott. (Academic Press, New York), 1963. Pp. xii + 340. Price 64 sh.

This survey is primarily for the college teacher. Scientists, in distant fields, would also enjoy these articles.

The chapter on "High Temperature Reactions" by A. W. Searcy reveals how usefully the displacements of metals by metals, and non-metals by non-metals can be treated in terms of basic thermodynamic generalizations. R. E. Rundle, writing on structure and valence, explains with examples, how, by extending Lewis rare gas rule to "sharing of an electron pair among two or more atoms" the electron-deficient, outer D-orbital and other valence anomalous compounds all come into line. R. Schaffer focuses, on a small frame, the various modern methods in "New research tools of chemists".

K. Wiberg has written on "Oxidation Reduction Mechanisms"; selective examples have been chosen and developed logically. It contains the best brief presentation of chromic acid oxidation and hydrogen abstraction mechanisms. The Grignard reaction, though it has been extensively used, needs considerable study regarding structure of the reagent and mechanism of the reaction. R. M. Salinger's article gives a good picture of the position as it is today. The structure and chemistry of those sandwich compounds, the metallocenes, have been presented by W. F. Little. Lipmann's 'metabolic dynamo' has been brought to date by P. Jencks in his article on "Chemistry of Biological Transfer" which deals with the source and utilization of energy and transfer mechanisms in biological systems.

G. B.

**Nitrogen Metabolism in Plants.** By H. S. Mckee.

(Clarendon Press, Oxford; India: Oxford University Press, Madras-2), 1962. Pp. vi + 728. Price £ 5-5 sh.

This book is a comprehensive compilation of the available literature on a difficult subject, written in a simple and lucid manner, with the topics arranged such that they lead on from one to the other, thus making for easy reading. Our ideas on the nitrogen metabolism in plants has undergone rapid changes in recent years, and still is, and even those engaged in research work in this area find it difficult to keep track of the developments. The author of this book has to be congratulated for bringing together in one book information and ideas which have emerged out of recent work. However, there are also

some lacunæ, thus the chapter on "Proteins and their synthesis" could have been a little more detailed and problems of "coding", role of ribosomes, etc., could have been included. What is most refreshing is the fact that the author has steered clear of controversial issues, presenting the view-points of the various research schools and leaving to the reader to make his own conclusions.

More than one hundred pages have been devoted to a complete 'Bibliography' which will be highly useful for those interested in this field. This book will definitely be an invaluable addition to libraries of research institutions in such fields as Agriculture, Biochemistry and Botany.

T. S. SADASIVAN.

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**Concrete Technology**—(Vol. 1: *Properties of Materials*), (Vol. II: *Practice*). By D. F. Orchard. (Asia Publishing House, Bombay-1), 1963. Pp. 358 and 463. Price Rs. 24 and Rs. 35.

The warm reception accorded to the earlier volume on the same subject has evidently encouraged the author to bring out a treatise on the same subject in two volumes.

The first volume deals with the various kinds and properties of cement including those used for lining oil wells, additives, aggregates, and concretes. The principles of concrete mix design and quality control have been discussed exhaustively. The latest developments such as the possibility of prestressing by chemical means and the effect of fineness of grinding of siliceous materials on puzzlonic effect have also found a place in the book. The second volume deals with testing of concrete as well as its constituents and of other topics essential for making, placing and testing good quality concrete both in the laboratory as well as in the field. Apart from dealing with the conventional methods of destructive testing various methods of non-destructive testing have also been described. In spite of the limitations of the latter method, it can still be a powerful weapon in the hands of the practising engineer, if it is judiciously used as a check on ensuring quality of work. Another subject of practical interest not usually dealt in most books is about the factors that can affect the quality of concrete, compaction and subsequent curing of concrete. The logic of the present practice of measuring the degree of curing by the number of days which have

elapsed after placing it, has rightly been questioned. The more rational method of measuring curing by its maturity has been discussed in great detail. There are useful chapters dealing with surface finishing of concrete and cast concrete and with mechanical handling of materials and mixing them to form concrete and later of transporting it for placement. The two volumes cover practically all the literature published on the subject in Western Europe and the States. There are hardly any references to work done in India—specially those pertaining to air entraining agents made indigenously and used in the construction of our dams, surki powder, fly ash and other puzzlonic materials in use here and reports of compression tests made on heavy blocks of concrete and stone masonry, etc.

The publishers deserve thanks for bringing out an inexpensive and neat edition of these useful books.

N. S. GOVINDA RAO.

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#### Books Received

*Structure and Metabolism of Corticosteroides.*

By J. R. Pasqualini and M. F. Jayle. (Academic Press, London W. 1), 1964. Pp. x + 168. Price 35 sh.

*Advances in Morphogenesis.* Edited by M. Abercrombie and J. Brachet. (Academic Press, 111, Fifth Avenue, New York-3), 1964. Pp. xi + 408. Price \$ 14.00.

*Penguin Science Survey.* Edited by Arthur Garratt. (Penguin Books Ltd., Middlesex, England). Pp. 229. Price: A-7 sh. 6 d.; B-7 sh. 6 d.

*Computer Programming—A Mixed Language Approach.* By M. L. Stein and W. D. Munro. (Academic Press, New York-3, N.Y.), 1964. Pp. xi + 372. Price \$ 13.50.

*The Romance of Teaching.* By Muriel Wasi. (Publication Unit, National Council of Educational Research and Training, 114, Sunder Nagar, New Delhi-11), 1964. Pp. 96. Price \$ 2.50.

*The Indian Year-Book of Education, 1964* (Second year-book)—*Elementary Education.* (Publication Unit, National Council of Educational Research and Training, 114, Sunder Nagar, New Delhi-11), 1964. Pp. xix + 752. Price Rs. 25-00.

*General Science Handbook of Activities* (Classes VI-VIII). (Publication Unit, National Council of Educational Research and Training, 114, Sunder Nagar, New Delhi-11), 1964. Pp. iv + 458. Price Rs. 9.50.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

University has awarded the Ph.D. Degree in Chemistry to Messrs. A. S. Mitra and Renuka Chandra Das for their theses entitled "Infrared Spectra of Diphenyl and Ketomethylene Compounds" and "Studies on Metal Complexes in Solution" respectively.

### Supplement to the List of Indian Fungi (1957-1962)

We have received from the Officer-in-charge, Miscellaneous University Studies, Botany Department, a copy of the publication, *Supplement to the List of Indian Fungi* by R. N. Tandon and Sankar Chandra. This 246 page publication includes the fungi recorded from India during the period 1957-62. The list has been arranged according to genera which are listed alphabetically. The publication will no doubt be useful to mycologists and plant pathologists.

### Effect of Manganese on Water Content of 'Solar' Salt

Sodium chloride produced by solar evaporation of sea water at various localities contains varying amounts of included water ranging from almost none to as much as 20% by weight. It is observed that, in addition to such factors as temperature and rate of crystallization, the presence of manganese in the brine has an important effect on the amount of mother liquor included in solar salt.

Among the metal ions causing liquid inclusions in sodium chloride crystal, only manganese will be present in sufficient amounts in sea brine to produce a possible effect. It can be derived from the soil of the crystallizing ponds and biomaterial as well as from the sea water. In the presence of decaying plant material sea water can extract appreciable amounts of manganese from soil, and this may be the major source of manganese in the brines of crystallizing ponds.

Prof. P. B. Sandell and Dr. C. Suraciti have reported the results of laboratory experiments on the effect of trace quantities of manganese on the inclusion of mother liquor by sodium chloride, by evaporating artificial and natural sea brine. According to them the laboratory-crystallized salt shows a minimum sodium chloride content when the manganese content of the crystal is 2-3 p.p.m., corresponding to a

manganese concentration of 1-4 p.p.m. in the brine. (*Nature*, 1964, 203, 60.)

### Trans-Neptunian Comet Belt

Current theories of the formation of the sun and the planets point to the existence of a large mass of small solid bodies at the outskirts of the solar system. The composition of these bodies is presumably similar to that of the outermost planets—Uranus, Neptune and Pluto—and these in turn appear to be comparable in composition to comets, which are believed to be icy conglomerates composed chiefly of frozen methane, ammonia and water. According to one theory the outermost planets are themselves accumulations of cometary material. Because of the low density of the outer parts of primordial gas cloud, cometary material beyond the gravitational reach of Neptune would not coalesce into planets but would remain in a trans-Neptunian ring approximately in the plane of the planets.

According to F. L. Whipple, Director of the Smithsonian Observatory, this belt of comets will have a total mass of 10 to 20 times that of earth. The gravitational effect on Neptune of such a belt of comets would account for the observed perturbations in Neptune's orbit, more satisfactorily than the present view which attributes them wholly to Pluto. According to calculations, if Pluto is responsible for the observed perturbations of Neptune's orbit, it should have a mass comparable to that of earth. Yet direct observations indicate Pluto's mass to be much less. (*Sci. Amer.*, August 1964.)

### Formation of Manganese Nodules on the Deep-Sea Floor

One of the interesting constituents of the deep-sea oceanic sediments which may eventually prove to be profitable of economic exploitation are the manganese nodules. These are small, black to brown concretions of about one to four inches in diameter distributed throughout on the floors of the three major oceans. Their presence was brought to light nearly a century ago by the famous *Challenger* Expedition.

The nodules are rich in manganese and iron which form nearly half of their weight, and besides, over 40 elements have been identified as constituents. Among these are the major ones nickel, cobalt and copper. Other materials include molybdenum, lead, zinc, zirconium, the rare-earth elements and also traces of radioactive elements.

In many cases the nodules show a very well-developed onion-skin structure centred around a macroscopic nucleus of some foreign material which may be almost of any composition, say, silicates, carbonates, phosphates, in fact any hard-surfaced object on the ocean floor exposed to the water and which can accrete the manganese-iron oxides.

The exact mechanism of formation of the nodules is not well understood but the following process may be envisaged. The elements iron and manganese are added to the ocean by streams and rivers, by submarine volcanic eruptions, by the dissolution of sea-floor rocks, and by sea-floor springs. With its slightly alkaline pH and highly oxidizing atmosphere, sea-water is essentially saturated with iron and manganese in solution. The evaporation of water thus tends to force the precipitation of these elements from sea-water. Possibly other agencies, such as bacteria or plankton, may be involved in the precipitation process. However, the net effect is the formation of colloids of these elements which gradually increase in size and slowly sink through the water to the sea floor. In transiting the water column, these sols of manganese and iron oxides apparently have the ability to scavenge from solution in sea-water many other elements such as cobalt, nickel, copper, lead, zinc, molybdenum and vanadium, which are known to be vastly undersaturated in sea-water. The scavenging effect of manganese and iron sols is well known in the laboratory and is used in chemical operations to remove certain ions from solutions in the parts per million range. As they reach the sea floor, the particles are swept along by the water currents until they touch some hard, reactive surface which functions as a centre of accretion.

Bacteria may also play a role in the formation of the nodules. The concentric, onion-skin-like structure of the nodules is common of manganese oxide deposits formed by bacterial action on land.

Radioactive elements which are found in the nodules in very small quantities offer a means of dating the shell layers within the nodules and thus measuring their rate of growth. The rates determined vary from location to location, but an average value would be about 0.1 mm. per 1,000 years. From sea-floor photographs it is estimated that about 20% of the ocean-floor area where nodules are forming is physically covered by nodules. According to John L. Mero (of the Newport News Shipbuilding and Dry Dock Company, Virginia, who presented this

paper before the New York Academy of Sciences) the nodules are presently forming at a rate of about 10 million tons in the Pacific Ocean.—(Trans. N.Y. Acad. Sci., March 1964.)

### Jodrell Bank *Mark II* Radio Telescope

The Jodrell Bank Radio Telescope (*Mark I*), with its 250-foot aperture paraboloidal bowl, has been successfully functioning since it was brought into commission in 1957, and is well known not only to radio astronomers but also to the general public because of its popular association with the tracking of *Sputniks*, satellites and space probes. At the time of its planning and construction the primary object in view was the study of radio emissions from space in the metre wavelength. Its performance in this region, and even in the range up to 50 cm. has been proved to be close to the theoretical level. The telescope has also been widely used with tolerable accuracy down to the hydrogen 21 cm. wavelength. But the accuracy falls off rapidly at shorter wavelengths, and at 10 cm. and less neither the bowl profile nor the control system is sufficiently accurate to make meaningful observations.

During the past few years the centimetre part of the radio spectrum has proved to be a region of great interest. British radio astronomy felt the need for a new telescope specially planned for accurate observations in this region. With the grant-in-aid from the DSIR it has been made possible for Jodrell Bank to construct *Mark II* which is about to be put into operation for its research programmes in the centimetre wavelength.

The reflecting membrane of *Mark II* is an elliptical paraboloid with major axis 125 ft. and minor axis 83 ft. 4 in. formed of continuous welded 12 s.w.g. steel sheets. The focal length is 40 ft., and just above the focal point there is an 8-ft. cube laboratory supported on four legs rising from the edge of the bowl structure.

The telescope can be operated under full automatic control. A Ferranti *Argus* 104 computer will compute and control the azimuth and elevation from a punched tape input to give sidereal and other movement as desired. A first routine programme with *Mark II* will be to measure the spectra of the large number of known radio sources at wavelengths of 11 and 6 cm. Observations of the spectral structure in the centimetre wavelengths will give important information about the process of emission in the distant radio galaxies.—(*Nature*, 1964, 203, 11.)



# THE NEW PHYSIOLOGY OF VISION

## Chapter III. Corpuscles of Light and the Perception of Luminosity

SIR C. V. RAMAN

IN a communication published under the title "Fluctuations of Luminosity in Visual Fields" in the issue of *Current Science* on the 5th of February, 1964, a phenomenon discovered by the author was described, the general features of which indicated it to be a consequence of the corpuscular nature of light. The circumstances in which the phenomenon was observed and the nature of the effects seen were as follows. The observer views a uniformly illuminated surface situated at a sufficient distance from himself; it is noticed that its luminosity does not appear uniform or static, but exhibits fluctuations over its entire area. The nature and magnitude of the observed effects depend greatly on the strength of the illumination. A particularly noteworthy feature is that the fluctuations continue to be conspicuously noticeable even when the illumination of the screen is thousands of times more powerful than the absolute threshold at which the sensation of light itself vanishes.

The earliest observations of the phenomenon were made without any special arrangements. The illuminated surface was that of a wall in a darkened room on which the light of the sky entering through a ventilator near the roof fell. The wall was itself distempered with a pale green wash and this greatly reduced the brilliancy of the light diffused by it. The observations were made in the early hours of the morning after dawn so that the effect of the gradually increasing strength of illumination could be very conveniently followed, the observer being at a fixed distance from the wall. Subsequent observations under controlled conditions in a laboratory revealed the influence of varying the distance of the observer from the screen as well as the highly important role played by the spectral character of the light in the observed phenomena. It was discovered that the effects were most conspicuous when the screen was illuminated with monochromatic light; the effects though observable with light of all wavelengths differed greatly in the measure of their conspicuousness for different parts of the spectrum.

*Observations with Monochromatic Light.*—The definitive studies of the phenomenon were made in a fairly large laboratory room. This

was ten metres square and could be completely darkened. The observations were made using a plastic sheet which was perfectly white and 150 cm.  $\times$  100 cm. in area as the screen. This was fixed vertically on a stand so that the distance of the screen from the source of light as well as the distance of the observer from the screen could be independently varied. The surface of the screen had a smooth polish, so much so that the reflected image of the source of light was seen sharply defined; but setting the screen suitably with reference to the positions of the source and the observer, the reflection could be put out of sight, and only the light diffused by the material of the screen was visible. The screen was uniform and completely free from blemishes, so much so that its diffusing power showed no detectable variations over its entire area.

Monochromatic illumination of the screen could readily be achieved by using a sodium-vapour lamp of modest size. This was enclosed in a box provided with an adequate opening on one side and this was covered over by a diffusing screen of ground glass. The illumination of the distant screen could be varied over a wide range of values by covering the aperture through which the light issued with an iris diaphragm: this could be altered continuously from an opening of ten centimetres diameter down to a millimetre, thereby enabling the illumination of the screen to be varied over a ratio of 1: 10000. As the distance of the screen from the source could be reduced from nearly ten metres down to about ten centimetres, its illumination could be further altered over a ratio of about 10000: 1. Thus, the intensity of the light falling on the screen could be varied from the maximum available in the immediate neighbourhood of the source to a value smaller than that maximum by a factor of about  $10^{-8}$ . The strength of the illumination in the immediate neighbourhood of the aperture from which the light issued could be read with a light meter and was found (with the particular lamp under use) to be fifty foot-candles. When the diaphragm of the iris is closed down to the smallest value and the screen is at a maximum distance from the source, the illumination of the screen

was unobservable. Thus, the arrangements permit of the screen being viewed under a very wide range of intensities of illumination.

For obtaining monochromatic illumination other than that provided by a sodium-vapour lamp, the most suitable arrangement was found to be the use of a mercury-vapour arc of the high-pressure type enclosed in a quartz tube and to focus the image of the arc lamp upon the entrance-slit of a double-monochromator. An instrument of this kind obtained some years ago from Messrs. Kipp and Zonen in Holland was available and was found to be well suited for the purpose. By adjusting the position of the central slit within the instrument, the radiation of any of the chief mercury-arc lines ( $\lambda$  4046, 4358, 4916, 5461, 5780-5790 and 6100) could be effectively isolated from the rest of the spectrum and used to illuminate the distant screen. By varying the width of the slit through which the light finds entry into the monochromator, as well as of the slit through which it finally emerges, the intensity of the issuing beam could be increased in a very considerable ratio without any noticeable loss either in the monochromatism of the emerging light or of the uniformity of illumination of the screen. With the arrangements indicated the intensity of the emerging light is high in the immediate vicinity of the exit slit and can easily be read with a light meter: it falls off rapidly in a calculable ratio as we move away from the slit.

*Factors Influencing the Observed Effects.*—As has already been indicated, three factors influence the nature of the observed phenomena; *firstly*, the strength of the illumination of the screen; *secondly*, the distance of the observer from the screen; and *thirdly*, the spectral character of the illumination. With suitable arrangements, the effect of varying each of these factors could be separately studied. Before describing the observed results, a few remarks of a preliminary nature may be usefully made. It is desirable, though not absolutely essential, to make the observations in a room which has been completely darkened. The need for such darkening is obvious when we wish to make the observations at the lowest levels of illumination of the screen. But, even otherwise, it is desirable that the eyes of the observer are not distracted by light reaching them from other sources than the screen under observation. Especially if such sources are much brighter than the screen itself would the distracting effect be serious. For the same

reason also, it is desirable that the observer should not proceed to view the screen immediately after entering the darkened room after a brightly illuminated exterior, but should allow a sufficient time for the visual after-images produced by exposure to strong light to disappear completely. The interval thus allowed would also serve for the adaptation of his vision to the level of illumination of the screen actually under study: the time-interval needed for such adaptation would be a few minutes if the level is high and would be much longer if the level is very low.

A further remark is here needed regarding the characteristics of vision of the observer. It is necessary, of course, that the screen should be seen distinctly by the observer from the position actually taken up by him. If his vision is good for both of his eyes for all distances, no further comment need be made. It is often the case, however, that vision of one eye is much better than that of the other; the observations can then be made with both eyes open, for the phenomena are effectively those seen by the eye of which the vision is good. If the vision of both eyes is equally good, it is found that the fluctuations are better seen when one eye or the other eye is covered up than with both eyes open. This is a clear indication that the fluctuations as seen by the two eyes are independent of each other and the binocular superposition tends to make them less conspicuous than otherwise. If both of the eyes are optically defective, it is necessary to wear correcting glasses. But this is not needful for observations made with screens held at a sufficient distance, if at least one eye of the observer has good vision for distant objects.

*Effect of Varying the Luminosity.*—As has already been indicated, the strength of the illumination of the screen may be varied by one or another of two methods or by both together; *firstly* by altering the luminous flux issuing from the light source and *secondly* by varying the distance of the screen from the source. The former method has the advantage that the observer can remain at a fixed distance from the screen, and hence the effect of varying the distance does not arise. The change in the strength of the illumination can be effected in a quantitative fashion using the sodium-vapour lamp and varying the aperture of the iris diaphragm as already described. Using this technique, it is found that the fluctuations of luminosity of the screen are discernible over

a great range of strength of its illumination. But the observable characters of the fluctuations differ greatly at different levels of illumination. The differences observed are of three kinds: firstly, in respect of the degree of contrast observable as between the darker and brighter areas in the fluctuating illumination; secondly, in respect of the rapidity with which the changes occur; and thirdly, in respect of the sizes of the areas of brightness and darkness seen on the screen. We may describe the differences which are observed succinctly as follows. In the higher ranges of illumination, the contrasts between the areas of darkness and brightness are less, the areas themselves are distinctly smaller, and the changes with time are more rapid. At the lower levels of illumination, the contrasts are more striking, the areas are larger and the changes with time are slower. These differences in the characters of the fluctuations occur progressively with the decreasing strength of illumination.

*Effect of Varying the Observer's Position.*—When the observer alters his location and approaches an illuminated screen, the flux of illumination from any given area of the screen which finds entry into the pupils of his eyes increases in the inverse proportion of the square of his distance from the screen: but the image of that area formed on the retina of his eyes increases in size in the same proportion, and hence it is not to be expected that the luminosity of the screen as actually perceived would alter sensibly. Actually, it is found the fluctuating pattern of varying intensities visible on the screen progressively increases in the absolute scale or size of its details as the observer moves away from the screen: *per contra* the details seen in the pattern visibly contract as he moves towards the screen. But other features of the pattern, viz., the contrasts between light and shade, and the rapidity of the fluctuation do not seem to alter. In the higher ranges of illumination of the screen, however, the patterns of fluctuation themselves are on a small scale and also change rapidly with time. Hence, it becomes more and more difficult to recognise the existence of the fluctuations when the observer approaches too closely to the screen under observation. For these reasons, it is desirable that he takes his stand at a reasonable distance, say, a metre or two from the screen. When, however, the illumination is very low, he can approach much closer and still have no difficulty in recognising the varying patterns of light and shade moving over the screen.

*Influence of the Spectral Composition.*—As is well known, the intrinsic luminosity of the visible spectrum varies greatly over the range of wavelengths included in it as we pass from one end of the spectrum to the other. The absolute level of illumination and the particular region of the retina made use of for the observations are also known to influence the form of the spectral luminosity curve. In these circumstances, it is only to be expected that the character of the fluctuations of luminosity visible on an illuminated screen would depend greatly on the spectral position of the light employed for the observations. The light of the sodium-vapour lamp is not far in its position from the point of maximum luminosity in the spectrum at high levels of illumination. Since the fluctuations of luminosity are conspicuous with sodium light over a great range of intensities of illumination, one may expect that monochromatic light from the parts of the spectrum of which the intrinsic brightness is lower should exhibit the phenomena even more conspicuously. This is indeed found to be the case as we move from the yellow into the red, and also as we move from the yellow into the green and then into the blue and the violet. Indeed, the fluctuations of luminosity on a screen illuminated by the  $\lambda 4358$  radiations of the mercury lamp are conspicuous even at high levels of illumination; indeed much more so, than could have been anticipated on the basis of the low intrinsic luminosity of the  $\lambda 4358$  radiation as compared with the  $\lambda 5896$  light of the sodium lamp.

*The Origin of the Fluctuations.*—The energy carried by an individual corpuscle of light is an exceedingly small quantity, and the number of corpuscles corresponding to even a moderate light-flux incident on a screen is therefore enormously large. As has already been noted in the preceding chapter, a lumen of illumination of wavelength of  $555\text{ m}\mu$  falling on an area of one square metre is equivalent to the incidence of  $4.3 \times 10^{15}$  quanta on it per second of time. This number being enormous, it might seem incredible that observations of an illuminated screen should enable us to perceive any noticeable fluctuations in brightness. The paradox is however resolved when we consider the situation more closely. We have to take note of two distinct features in the situation which conspire and give rise to the observed effects. The first is the corpuscular nature of light. The second is the discrete structure of the retina. For light to be perceived, a corpuscle of light has not merely to fall on the

retina, but has actually to be trapped by one of the receptors forming the fine structure of the retina and its energy transformed into an electrical impulse transmitted along the associated nerve-fibres to the cerebral centres involved in the perception of light. Such absorption of the corpuscle and the transformation of its energy is *a chance event* as has already been remarked in the preceding chapter. It should be noted in this connection that the range of illumination in which our eyes can function is enormous. For instance, the illumination of a screen on which direct sunlight is incident is of the order of 25000 lumens per square metre. It is not pleasant to view such a brightly illuminated surface, but we can certainly do so for a little while without any disastrous effect on our visual faculties. In the circumstances, we are justified in assuming that the chance of a light corpuscle falling on the retina being trapped and transformed into an impulse carried by the optic nerves is exceedingly small, not greater than one in a hundred, and perhaps even less.

Granting that the perception of light by our eyes is the resultant of the individual chances of absorption of a light corpuscle by one of the receptors in the retina, the way is open to an explanation of the fluctuations of luminosity actually observed. Here, we have also to take note of the fact that only an exceedingly small fraction of the number of light corpuscles reaching the surface of a screen and diffused by it can find their way into the pupil of an eye of the observer. This fraction is the ratio of the area of the pupil to the area of the surface of a hemisphere drawn with an element of area of the illuminated screen as its centre and having as its radius, the distance of the observer from the screen. If we take the diameter of the pupil as five millimetres and the screen to be two metres distant from the observer, the chance of a light corpuscle from such element of area finding its way to the retina is reduced in the ratio of 1 to 3,200,000. This factor will be further reduced by the small probability (already noticed) of a corpuscle reaching the retina being actually perceived as light. Further, *to enable the screen to be perceived by the eye as uniformly illuminated, it is necessary that every one of the individual receptors in the retina should be fully engaged*

*all the time in receiving light corpuscles, absorbing them and passing on the absorbed energy in the form of nervous impulses, and that this process is repeated once in every small fraction of a second of time.* When it is further remarked that in the foveal depression in the retina alone, there are 100,000 individual receptors, it will be realised that even when the illumination of the screen is as high as one lumen per square metre, it is extremely unlikely that the situation envisaged above could actually exist. Only a fraction of the receptors determined by the laws of chance would be actually functioning at any given instant. That fluctuations of luminosity over the area of the screen would be observed follows as a natural consequence of these considerations.

*Some Further Remarks.*—What has been stated above enables us to proceed a little further and to offer a reasonable explanation of the features observed in various circumstances and set forth above. The smaller the luminous flux incident on the screen, the less would be the proportion of the receptors of vision actually functioning at any given time. Hence the larger would be the areas in which variations of brightness would manifest themselves; the contrasting areas of light and shade would be larger in size, the contrasts themselves would be more readily perceptible, and the changes from greater to lesser brightness occur less rapidly. An increase of the luminous-flux incident on the screen would produce the reverse effects. As the observer moves away from the illuminating screen, the actual number of light corpuscles reaching any particular region of his retina would not alter appreciably. But the image of the fluctuations in the response of the retina seen projected on the illuminated screen would be enlarged in proportion to its distance from the observer, and this is what is actually observed. Finally, the very striking nature of the fluctuations observed when the illuminating radiation is in the region of shorter wavelengths becomes intelligible when it is recalled that the corpuscles in this region represent larger quanta of energy and are therefore for the same energy fewer in number, and that the chances of the corpuscles being actually absorbed and giving rise to visual impulses is necessarily much smaller, in view of the very low luminosity of these regions of the spectrum.

## SYNTHETIC ANALOGUES OF PLANT INSECTICIDES

A. S. KUKLA AND T. R. SESHADRI

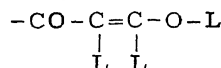
Department of Chemistry, University of Delhi, Delhi-6

THE discovery of selective plant insecticides meant a great advance in our fight against insect enemies because they were very toxic to insects and comparatively harmless to human beings. They could therefore be used freely as domestic insecticides. At first pyrethrum flowers and derris roots formed the most important sources of these insecticides. As a result of continuous work, the discovery of the valuable properties of D.D.T. and B.H.C. and similar chlorine rich insecticides was made. At one time these were considered to be non-toxic and comparatively safe to human beings and pet animals. Later studies have however shown that they are not only toxic but suffer from two important defects namely (i) presence of residual toxicity and (ii) development of insect resistance. Similar defects exist in the well-known phosphate insecticides which are definitely more poisonous. This has led to the revival of interest in plant insecticides, particularly pyrethrum flowers and derris roots because they do not suffer from the two defects mentioned above.

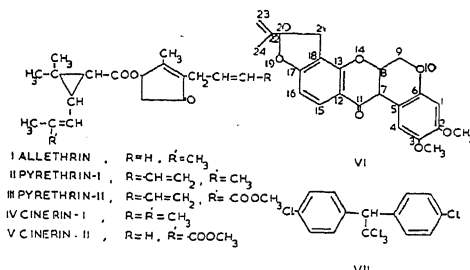
Another line of study has been followed in recent years. The constitutions of the active principles of pyrethrum have been settled. Though their laboratory synthesis has been effected, their synthetic production on a large scale is difficult and expensive as it involves a number of difficult steps. On the other hand it is possible to prepare comparatively simpler analogues which are appreciably toxic and can be synthesized in large quantities in an economic way. Allethrin is a success in this manner. Relationship between this structure (I) and of those present in the pyrethrums (II, III, IV and V) are indicated in the formulæ. Synthesis of allethrin (I) itself involves thirteen steps and is therefore complex for an industrial chemical but the compound is most effective against houseflies and the commercial synthesis has been worthwhile.

Derris root contains a number of active principles of which rotenone is the most potent. Rotenoids have been used as insecticides against leaf-eating caterpillars<sup>1</sup> and for the control of plant feeding pests especially where toxic residues are not desired. Though the complete synthesis of rotenone has been accomplished,<sup>2</sup> it is extremely difficult and costly and is only of academic interest. Efforts have, therefore, been made to get simpler analogues

which will approach rotenone in toxicity and could be easily and economically prepared. The main difficulty in such studies is the lack of correct understanding of relationship between insecticidal properties and chemical constitution. Information on this subject was originally very limited. Luger *et al.*<sup>3</sup> believed that toxic property of rotenone is due to the presence of the toxophoric grouping



where L represents the lipid solubilizing groups like benzopyran, benzofuran and methoxyl groups. Martin,<sup>4</sup> however, felt that hydrogen atoms of the central ring of rotenone (VI) at 7, 8-positions are important in determining the toxicity. This is primarily based on the observation that dehydrorotenone and the methyl ether of the enolized rotenone<sup>5</sup> in which this part of the molecule is effected are much less toxic. Hummer and Kenaga<sup>6</sup> lay stress on the steric structure of rotenone and point out that in the *cis*-configuration of rotenone, the distance between oxygen atoms at 2 and 19 positions corresponds to that between the *p*, *p'*-chlorine atoms of D.D.T. (VII) assuming that the two molecules participate in a common biochemical process.



It is important to note that the above studies were primarily meant to explain the marked toxicity of the rotenone molecule and fail to provide any definite reason for the inferior toxicity of the other rotenoids. However, interest in this subject has provided considerable amount of information on the toxicity of compounds having simple benzopyrone structures like coumarins, flavones and isoflavones.

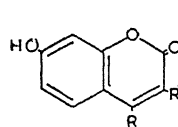
An important feature in the above studies is the method of determining the toxicity. Fish<sup>7</sup> have been employed as a test animal for the study of insecticidal action. Earlier workers

used death-point for the evaluation and this was indefinite. A suitable method for evaluating fish-toxicity is by Krishnaswamy and Seshadri.<sup>8</sup> It is based on the observation that the fish when exposed to the action of a toxicant invariably lost balance and overturned before they sank. The stage at which they overturned, seemed to be fairly definite and was employed as a measure of toxicity. Thus using a number of test-fish, the average turning-time was measured against a definite concentration. The results were reliable in the range of concentrations where the curve for the relation between concentration (c) and turning-time (t) is an equilateral hyperbola. In this range the product of c and t is roughly a constant. The method is efficient and using this technique, the toxicities of a number of groups of compounds given below have been studied.

#### COUMARINS

Among simple molecules, coumarins were the earliest to be studied for fish toxicity. Späth<sup>9</sup> found simple coumarins to be feebly toxic and Mahal<sup>10</sup> observed that 4-methyl umbelliferone (VIII) does not possess appreciable anthelmintic properties. Luger *et al.*<sup>3</sup> also stated that simple coumarins have only weak insecticidal properties. They found 3-acetyl-4-hydroxy coumarin appreciably toxic and attributed the toxicity to its resemblance to the insecticide dehydracetic acid. Later, a detailed study was made by Murti and Seshadri<sup>11</sup> who observed that simple coumarin derivatives are considerably less toxic as compared with flavone derivatives and attributed it to the lack of side-phenyl nucleus in them. Therefore, a number of phenyl-substituted coumarins<sup>11</sup> were studied and were found to be markedly toxic. It was observed that the presence of a phenyl group at the 3-position of a coumarin molecule was most favourable for toxicity, probably because of its structural resemblance to the rotenone skeleton. Further substitution did not enhance the toxicity; 3, 4-diphenyl umbelliferone (IX) was found to be less toxic than 3-phenylumbelliferone (X). Later, Seshadri and Varadarajan<sup>12</sup> examined a number of halogen substituted coumarins with substituents in different positions and observed that halogen substitution at the 3-position is far superior to nuclear substitutions at position 6- or 8-. 3-Bromo-4-methyl umbelliferone (XI) was found far more toxic than 8-bromo-4-methyl umbelliferone (XII). However, in conjunction with a halogen atom at the 3-position, another halogen atom in the 6- or 8-positions enhances the toxic properties

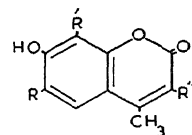
considerably. Thus, 3, 6- and 3, 8-dibromo-4-methyl umbelliferones (XIII and XIV) were found to be more toxic than the corresponding 3-monobromo compound (XI). Higher halogen substitution is not favourable and 3, 6, 8-tribromo compound (XV) was found to be less toxic than either the mono- or dibromo umbelliferones mentioned above.



VIII, R = CH<sub>3</sub>, R' = H

IX, R = R' = C<sub>6</sub>H<sub>5</sub>

X, R = H, R' = C<sub>6</sub>H<sub>5</sub>



XI, R = R' = H, R'' = Br

XII, R = R' = H, R'' = Br

XIII, R = R' = Br, R'' = H

XIV, R = H, R' = R'' = Br

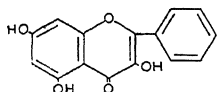
XV, R = R' = R'' = Br

#### FLAVONES

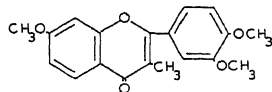
In 1934, Ratnagiriswaran *et al.*<sup>13</sup> reported that calycopterin had anthelmintic action. However, a few years later Mahal<sup>10</sup> found 7-hydroxy flavone, 6-hexyl-7-hydroxy flavone, chrysin, genkwanin and calycopterin to be non-toxic to tapeworms and leaches. Using fish as test animal Krishnaswamy and Seshadri<sup>8</sup> observed that karanjin was markedly toxic. In view of the above conflicting reports, a careful investigation of the subject was necessary. Consequently, a number of hydroxy flavones and their methyl ethers were studied<sup>14-15</sup> and it was observed that simpler flavone derivatives are markedly toxic to fish. Among the hydroxy flavones the following were tested: 7-hydroxy flavone, chrysin, 3, 7-dihydroxy flavone, galangin, kampferol, quercetin and myricetin and were found to be feebly toxic. The maximum effect was found in galangin (XVI), chrysin and 3, 7-dihydroxyflavone coming next. The methyl ethers of these compounds were studied and found to be more toxic. The following decreasing order of toxicity was found: 7-methoxy flavone > 3, 7-dimethoxyflavone > galangin trimethyl ether > kampferol tetramethyl ether > herbacetin pentamethyl ether > quercetin pentamethyl ether and quercetagenin hexamethyl ether. The above results thus indicated that in the flavone series the toxicity decreased with the increase in the number of methoxyl groups.

A detailed study of some 3-methyl, -phenyl and -ethyl substituted derivatives of simple flavones has been recently made by Sriman-narayana and Rao<sup>16</sup> who found that an allyl

group in the position 3 and methoxyl groups in positions 3' and 4' appreciably enhance the toxicity. 7, 3', 4'-trimethoxy-3-methyl flavone (XVII) has been found to possess the highest toxicity among the flavone derivatives. A study of flavanones was also made<sup>17</sup> and they resembled flavones in a general way in fish toxicity.



XVI



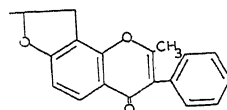
XVII

## ISOFLAVONES

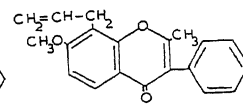
It has been pointed out earlier that there is marked difference in the toxic properties of simple coumarins and flavones and this was attributed to the absence of the side phenyl nucleus in coumarins. Similarly simpler chromones also had little toxicity.<sup>18</sup> Therefore, Murti *et al.*<sup>18</sup> examined isoflavones which possess the basic rotenoid skeleton and they found them to be markedly toxic. Allyl ethers were more potent than methoxy compounds and the latter more potent than the corresponding hydroxy compounds. Further, increase in the number of methoxyl groups seemed to decrease the toxicity. 7-Methoxy-2-methyl isoflavone was three times as toxic as 5, 7-dimethoxy-2-methyl isoflavone and 8-allyl-7-methoxy-2-methyl isoflavone (XIX) was the most toxic. Later, Sarin *et al.*<sup>19-20</sup> studied the toxicities of some allyl- and dihydrofurano-2-methyl isoflavones. These compounds also were markedly toxic but increased substitution was again not a favourable feature. For example,  $\alpha$ , 2-dimethyl-7, 8-dihydrofurano isoflavone (XVIII) was more toxic than  $\alpha$ ,  $\alpha'$ , 2-trimethyl-7, 8; 5, 6-tetrahydrodifurano isoflavone.

As could be seen from the above results, increase in the methoxyl or other substitution in the isoflavone molecule did not favour toxicity. This result looked rather anomalous, especially when rotenoids themselves are highly substituted compounds. Consequently, Kukla and Seshadri<sup>21</sup> studied the effect of methoxyl substitution in the side phenyl nucleus of isoflavones on insecticidal properties. It was observed that methyl substitution at the 2-position enhances the toxicity towards fish. This is in consonance with the fact that rotenoids themselves are 2-substituted isoflavonoids. Introduction of a single methoxyl group in the side phenyl nucleus does not appreciably affect

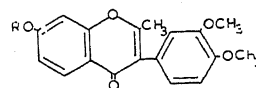
the toxicity. However, introduction of two methoxyl groups had varying effects; if they were at 3', 4' (or 4', 5') positions they considerably increased the fish toxicity and 7-dimethylallyloxy-3', 4'-dimethoxy-2-methyl isoflavone (XX) was found to be highly toxic. It was a useful observation that when dimethylallyl ( $C_7$ ) group of (XX) was replaced by simple allyl ( $C_3$ ) group the toxicity was further enhanced and 7-allyloxy-3', 4'-dimethoxy-2-methyl isoflavone (XXI) was found to be the most toxic of the series, its toxicity being about 1/2 to 1/3 of natural rotenone. This compound can be conveniently prepared in three steps,<sup>21</sup> starting from 3, 4-dimethoxyphenyl acetonitrile which is commercially available.



XVIII



XIX

XX, R =  $CH_2CH=CH(CH_3)_2$ XXI, R =  $CH_2CH=CH_2$ 

In addition to the above fish tests, the toxicity of 7-allyloxy-3', 4'-dimethoxy-2-methyl isoflavone (XXI) against mosquitoes has been tested using topical application method and it has been found to be about a third as toxic as natural rotenone. One  $\mu$ l. of acetone solution of various concentrations of the insecticide was applied on the thorax of anaesthetised insects by means of the micrometer syringe. After application the insects were kept under observation for 24 hours and the morality in them was then recorded. The LD 50's obtained against *C. fatigans* and *A. aegyptii* are given below. Rotenone has been used as standard of comparison.

TABLE I

Sample	Species of insects	LD 50 ( $\mu$ g./insect)
1. Isoflavone (XXI)	<i>A. aegyptii</i>	[ 0 0 ] 14.0
Rotenone	"	[ + + ] 4.8
2. Isoflavone (XXI)	<i>C. fatigans</i>	[ 0 0 ] 20.0
Rotenone	"	[ + + ] 5.0

From the above results, therefore, it could be concluded that not merely the increase or decrease in substitution but other structural features of the rotenoid molecule are essential

for the insecticidal action. It was originally the impression that any deviations from the rotenone structure reduces toxicity. However, as shown in the above-mentioned experiments simpler compounds have appreciable toxicity and they are easily prepared, as for example 7-allyloxy-3', 4'-dimethoxy-2-methyl isoflavone and 7, 3', 4'-trimethoxy-3-methyl flavone and hence there is promise of a synthetic flavonoid taking the place of rotenone, just as allethrin has done as synthetic substitute for pyrethrum.

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## REVERSAL OF OROTIC ACID FATTY LIVER BY ACTINOMYCIN D

S. RAJALAKSHMI, D. S. R. SARMA, D. E. LEELAVATHI AND P. S. SARMA

Department of Biochemistry, Indian Institute of Science, Bangalore-12, India

**T**HE analysis of the total RNA of the livers of rats administered with orotic acid revealed an enhanced ratio of pyrimidine to purine nucleotides (Rajalakshmi, Sarma and Sarma, 1961). The study of the incorporation of orotic acid-6-C<sup>14</sup>, adenine-8-C<sup>14</sup> and P<sup>32</sup>-phosphate into RNA provided further evidence for the synthesis of nucleic acid with altered base composition (Rajalakshmi, Sarma, Leelavathi and Sarma, 1964). Evidence is presented in this communication for the formation of actinomycin D sensitive 'liponucleoprotein' (LNP) in the orotic acid-fed rats as well as the reversal of orotic acid fatty liver by this antibiotic.

Young weanling rats weighing 40-60 gm. were employed in this experiment and fed with purified diet containing 1% orotic acid (Rajalakshmi *et al.*, 1961) for four weeks. The livers were perfused with cold 0.25 M sucrose before analysis. Subcellular fractions were obtained by the differential centrifugation technique of Hogeboom (1955) using Servall RC-2 refrigerated centrifuge and Spinco Model L preparative centrifuge.

**'Isolation of Liponucleoprotein'.—**The centrifugation of the homogenate, prepared from the livers of orotic acid-fed rats, yielded a fluffy white material at the top of the homogenate. This material separated out even when the homogenate was spun at low speed used for the

isolation of nuclei. Examination under polarising microscope showed no nuclear contamination. However, in order to avoid contamination of cellular particles completely, the rat liver homogenate was spun at 105,000 × g for 1 hour. The material was skimmed carefully and resuspended in 0.25 M sucrose and centrifuged to free it from adhering supernatant fraction. It was washed with cold 4% TCA and then repeatedly with Bloor's mixture, once with acetone, finally with ether and then dried. About 75-125 mgm. of solid material in a fine powder form was obtained from about 5-8 gm. of wet liver. The livers of normal rats had no such material. The concentration of alcohol, acetone and ether washings yielded appreciable quantities of lipid. The lipid was found to contain triglycerides, phospholipid, cholesterol and free fatty acids. Labelled amino-acids (phenylalanine-U-C<sup>14</sup>, lysine-U-C<sup>14</sup>, valine-1-C<sup>14</sup> and tryptophane-7-C<sup>14</sup>) and precursors of nucleic acid (adenine-8-C<sup>14</sup>, orotic acid-6-C<sup>14</sup> and formate-1-C<sup>14</sup>) were incorporated into LNP by the orotic acid-fed rat. The base composition of two randomly selected samples of LNP as determined by the method of Zschile and Munay (1963) are presented here A : G : U : C :: 10 : 14 : 29 : 28 ; 10 : 15 : 19 : 19. Actinomycin D inhibited the incorporation of orotic acid-6-C<sup>14</sup> into LNP to an extent of 80%. Further, the LNP disappeared



almost completely within 24 hours following the administration of actinomycin D. With the removal of LNP from the liver, more than 50% of the accumulated lipid also has vanished. In order to find out whether the prolonged effect of actinomycin D could reverse completely the fatty liver condition, a single dose of actinomycin D (30  $\mu$ g./100 gm. body weight) was given intraperitoneally and the animals were killed at an interval of 24 hours over a period of 6 days.

TABLE I  
Effect of actinomycin D on orotic acid fatty liver

Supplements to the basal diet		% total lipid (wet liver)	Cholesterol level		Pyridine nucleotides $\mu$ g./gm. wet liver
			mgm.—mgm./		
			wet liver	100 ml. serum	
Nil	..	5.1	286	100	724
Actinomycin D	..	8.2	298	80	800
Orotic acid 1 %	..	30.0	568	48	302
Orotic acid 1 % + Actino- mycin D, 24 hrs.	..	14.5	401	55	418
Orotic acid 1 % + Actino- mycin D, 48 hrs.	..	10.2	398	50	530
Orotic acid 1 % + Actino- mycin D, 72 hrs.	..	6.7	310	68	752
Orotic acid 1 % + Actino- mycin D, 96 hrs.	..	8.7	300	75	790
Orotic acid 1 % + Actino- mycin D, 120 hrs.	..	7.5	298	80	800
Orotic acid 1 % + Actino- mycin D, 144 hrs	..	7.0	305	100	780

Each value represents the average of two rats. The experiment was repeated thrice and the same pattern of results was obtained. Actinomycin D was a gift from Merck Sharp and Dhome, N.Y.

The results presented in Table I reveal that the administration of actinomycin D to the orotic acid-fed rat has resulted in a progressive decrease in the level of total lipid and cholesterol in the liver with a concomitant increase in that of serum cholesterol. The level of pyridine nucleotides also was restored to normal by actinomycin D in the orotic acid-fed rat. In order to eliminate the error due to a difference in food intake the lipid level in the following groups was estimated and compared with those receiving 1% orotic acid daily. (1) Orotic acid-treated rats starved for 48 hours. (2) Orotic acid-treated rats fed the control diet for 72 hours. (3) Orotic acid-treated rats given the same amount of diet as consumed by actinomycin D administered rats. The lipid level in these rats was found to be 28% and those fed with orotic acid diet alone daily was 30%. It may therefore be concluded that the injection of actinomycin D was responsible for the disappearance of fat from the orotic acid-fed rats.

Earlier Suva *et al.* (1961) reported the reversal of orotic acid fatty liver by 6-azauracil. It was observed by us that the intraperitoneal injection of 6-azauracil at a level of 4 mgm./100 gm. body weight for three days prevented completely the formation of LNP and fatty liver.

The pyrimidine analogue 6-azauracil has been shown (Handschumacher and Pasternak, 1958) to depress the formation of uridylic acid from orotidylic acid by inhibiting the enzyme orotidylic decarboxylase. Hence, the conversion of orotic acid to uridylic acid appears to be necessary for the production of LNP and fatty liver. The primary effect of actinomycin D consists in blocking the synthesis of nucleic acid by inhibiting the DNA-dependent RNA polymerase. The secondary effect of actinomycin D is depolymerization of nucleic acid. It is very difficult at this stage of investigation to decide whether the reversal of orotic acid fatty liver by actinomycin D is due to its primary or secondary effect. Nevertheless, the results presented here constitute presumptive evidence to indicate the derangement of lipid metabolism due to orotic acid administration may be a direct consequence of changes in nucleic acid metabolism. The principal ways by which the effects of orotic acid feeding in rats can be nullified are (1) by the prevention of formation of uridylic acid from orotic acid by 6-azauracil and (2) inhibition of the utilisation of uridylic acid towards the synthesis of nucleic acid by actinomycin D. Increase of adenine nucleotides *via* the salvage pathway by providing exogenous adenine also reversed the orotic acid fatty liver (Handschumacher *et al.*, 1961).

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## LETTERS TO THE EDITOR

BEHAVIOUR OF THE QUEUEING  
SYSTEM WITH GENERAL INPUT AND  
RANDOM SERVICE TIME WITH  
A SINGLE SERVER

CUSTOMERS arrive at a counter according to a certain probabilistic law. The first come, the first served is the principle. The service times are random variables governed by a given probabilistic law. After service the customers depart.

Let  $t_1, t_2, \dots, t_n, \dots$  be the instants of the arrivals of the customers. It is supposed that inter-arrival times  $(v_n)$ , where  $v_n = t_{n+1} - t_n$ , are independently and identically distributed random variables, with prob.

$$[v_n \leq t] = F(t)$$

Let  $u_n$  be the service time of the  $n$ -th customer, and prob.

$$[u_n \leq t] = H(t) = \begin{cases} 1 - e^{-\mu t}, & \text{if } t \geq 0, \\ 0, & \text{if } t < 0. \end{cases}$$

Takacs<sup>1</sup> considered the transient behaviour of a single-server queueing process with Poisson input and general service time. A. N. Kolmogorov<sup>2</sup> and N. T. J. Bailey<sup>3</sup> have considered the process with random service, and random input with single server. The transient behaviour of the process with random input and general service time with single server was investigated by F. Pollaczek<sup>4</sup> and Takacs.<sup>5</sup>

For the queueing process considered here with general input and random service time with a single server, the author has obtained the  $n$ -th stage transition probabilities of the queue lengths, by employing the methods of imbedded Markov chain and generating functions. The agreement of the probabilities obtained by repeated multiplication of the matrix of one step transition probabilities by itself  $n$  times with the probabilities obtained by the formulae established in this paper is verified in a simple case which is given as an illustration. The probability  $k_j$  for exactly  $j$  departures in a single interval, is given by  $k_j = pr(x_n = j)$ , where  $x_n$  is the number of departures during  $(t_n, t_{n+1}^{-0})$

$$= \int_0^\infty e^{-\mu t} \frac{(\mu t)^j}{j!} dF(t), \quad j = 0, 1, 2, \dots$$

The generating function  $V^{(n)}(z)$  of the probabilities of the queue length at the  $n$ -th stage is obtained as:

$$\begin{aligned} V^{(n)}(z) &= \sum_{i=0}^{\infty} p_{ij}^{(n)} z^i, \text{ for } |z| \leq 1, \text{ and } j \text{ is fixed.} \\ &= \left\{ \frac{k(z)}{z} \right\}^n z^j + (1-z)^{-1} \\ &\quad \times \sum_{r=0}^{n-1} \left\{ \frac{k(z)}{z} \right\}^r p_{0j}^{(n-r-1)} \\ &\quad - (1-z)^{-1} \sum_{r=0}^{n-1} \left\{ \frac{k(z)}{z} \right\}^{r+1} \\ &\quad \times p_{0j}^{(n-r)} \dots (A), \end{aligned}$$

where

$$k(z) = \sum_{j=0}^{\infty} k_j z^j.$$

The coefficient of  $z^j$  on the R.H.S. of (A) gives the expression for the transition probabilities  $p_{ij}^{(n)}$  of the queue lengths from  $i$  to  $j$  at the  $n$ -th stage.

Expression (A) is the main result of the present paper.

I am thankful to Prof. K. Nagabhushanam for his help and encouragement.

Andhra University, P. V. S. SARMA.  
Department of Statistics,  
September 4, 1964.

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AN ELECTRONIC NULL INDICATOR  
FOR GLASS ELECTRODE  
MEASUREMENTS

THIS note describes an inexpensive type of electronic null indicator which is likely to find application in the measurement of potentials of electrochemical systems using glass electrodes as 'sensors'. In spite of the high impedance associated with the glass electrodes, the pFI meters using glass electrodes are becoming more and more popular with the advent of high input impedance, stable and sensitive electronic voltmeters developed. An attempt has been

$$\begin{array}{c} \text{CH}_3-\text{C}-\text{C}-\text{CONHR} \\ \parallel \quad \parallel \\ \text{O} \quad \text{N} \\ \searrow \quad \swarrow \\ \text{H} \quad \text{O} \end{array}$$
$$\begin{array}{c} \text{CH}_3-\text{C}=\text{C}-\text{CONHR} \\ \parallel \quad \parallel \\ \text{O} \quad \text{N} \\ \diagdown \quad \diagup \\ \text{M} \\ \frac{2}{\quad} \\ \text{or} \\ \frac{\text{M}}{3} \end{array}$$

where R = aryl group; M = metal,

TABLE I

(OAA) =  $\alpha$ -oximino acetoacetanilide; (OAPT) =  $\alpha$ -oximino acetoacet-*p*-tolalide; (OAOT) =  $\alpha$ -oximino acetoacet-*o*-tolulide; (OAN<sub>1</sub>N) =  $\alpha$ -oximino N-1-acetoacet naphthylamide; (OAN<sub>2</sub>N) =  $\alpha$ -oximino N-2-acetoacet-naphthylamide.

No.	Chelate	Appearance	M.P. °C.	Analysis	
				Found	Calculated
1	Cu (OAA) <sub>2</sub>	.. Light green	265	12.99	13.42 Cu%
2	Cu (OAPT) <sub>2</sub>	.. Green	160	13.35	13.47 "
3	Cu (OAOT) <sub>2</sub>	.. Dirty green	175	13.30	13.47 "
4	Cu (OAN <sub>1</sub> N) <sub>2</sub>	.. Greenish	203	10.95	11.08 "
5	Cu (OAN <sub>2</sub> N) <sub>2</sub>	.. Pale green	140	10.95	11.08 "
6	Ni (OAA) <sub>2</sub>	.. Light greenish	245	13.02	12.52 Ni%
7	Ni (OAPT) <sub>2</sub>	.. Dirty green	143	11.61	11.81 "
8	Ni (OAOT) <sub>2</sub>	.. Pale yellow green	188	11.73	11.81 "
9	Ni (OAN <sub>1</sub> N) <sub>2</sub>	.. Yellowish-green	275	10.42	10.32 "
10	Ni (OAN <sub>2</sub> N) <sub>2</sub>	.. "	116	11.27	10.35 "
11	Co (OAA) <sub>3</sub>	.. Light brown	255	8.66	8.75 Co%
12	Co (OAPT) <sub>3</sub>	.. Pale brown	199	7.80	8.24 "
13	Co (OAOT) <sub>3</sub>	.. Brownish-orange	189	8.08	8.24 "
14	Co (OAN <sub>1</sub> N) <sub>3</sub>	.. Reddish-brown	247	6.78	7.16 "
15	Co (OAN <sub>2</sub> N) <sub>3</sub>	.. "	167	6.27	7.16 "

All compounds are insignificantly soluble in water but are highly soluble in alcohol, acetone, benzene, toluene, xylene, chloroform, carbon tetrachloride and ether.

These products are not hydrolysed with water. The aqueous suspension when treated with H<sub>2</sub>S does not yield metal sulphides. They are highly soluble in various organic solvents. Therefore they have been shown to be metal chelates and not simple salts.

It is observed that the test papers prepared from 0.05 M reagent solution in ethanol could detect copper, nickel and cobalt separately and also in presence of other cations. All  $\alpha$ -oximino compounds behaved as sensitive reagents for copper (1 : 36000).

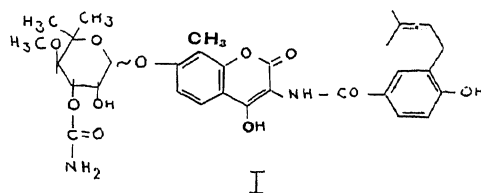
The rates of formation of metal chelates by spectrophotometric method and their magnetic properties, stability constants are under study.

Chemistry Department, R. M. DESAI.  
Sardar Vallabhbhai Vidyapeeth, M. R. PATEL.  
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## SYNTHESIS OF SOME NOVOBIOCIN ANALOGUES

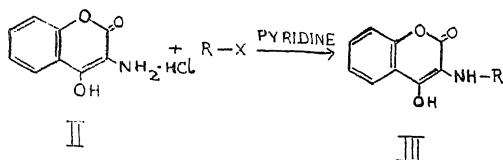
3-AMINO 4-hydroxy coumarins have acquired greater prominence in recent years with the isolation and study of the structure of the antibiotic Novobiocin (I).<sup>1</sup> It is primarily active against gram-positive micro-organisms and has proved to be of considerable use clinically, especially in the treatment of infections caused by Penicillin-resistant staphylococci.<sup>2</sup> Novobiocin is also reported to possess fungicidal<sup>3</sup> and amœbicidal<sup>4</sup> activities. Moreover, it has been found to be a potential anti-tubercular drug.<sup>5</sup> The antibacterial and antifungal properties of 3-amino 4-hydroxy coumarin itself have been investigated by Japanese<sup>6</sup> and Italian workers.<sup>7</sup>



With a view to testing the antibacterial and antifungal properties, some N-alkyl or aryl 3-amino 4-hydroxy coumarins and coumarino-(3 : 4) oxazoles have been synthesised. These may be regarded as analogues of Novobiocin.

The N-substituted 3-amino 4-hydroxy coumarins (III) have been prepared by refluxing

3-amino 4-hydroxy coumarin hydrochloride (II) with an alkyl or aryl or a heterocyclic halo compound in pyridine medium. Compounds prepared by this method are given in Table I.



was previously reported to be a good condensing agent for the preparation of oxazoles.<sup>9</sup> Compounds prepared by this method are given in Table II.

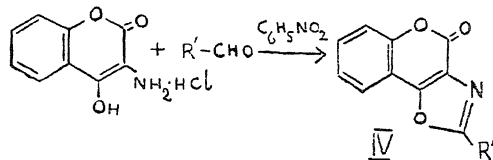
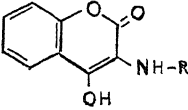
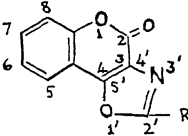


TABLE I  
N-alkyl or aryl substituted 3-amino 4-hydroxy coumarins \*

S. No.	R-X		M.P. (°C.)	Yield (%)
("R" only given)				
1	<i>n</i> -Propyl chloride	.. Propyl	90	40
2	Tert-butyl chloride	.. Tert-butyl	86	40
3	Cyclohexyl chloride	.. Cyclohexyl	140	45
4	Benzyl chloride	.. Benzyl	67	25
5	2 : 4-Dinitro chlorobenzene	.. (2 : 4-dinitrophenyl)	187	35
6	<i>p</i> -Chloro acetanilide	.. <i>p</i> -Acetamidophenyl	219	55
7	<i>p</i> -Chloro diphenyl	.. <i>p</i> -Diphenyl	71	50
8	$\alpha$ -Chloro naphthalene	.. $\alpha$ -Naphthyl	142	45
9	2-Chloromethyl benziminazole	.. 2'-Benziminazolylmethyl	224	60

\* All the compounds included in the table are reported for the first time.

TABLE II  
Coumarino-(3 : 4) oxazoles \*

S. No.	R'.CHO		M.P. (°C.)	Yield (%)
("R' only given)				
1	Benzaldehyde	.. 2'-Phenyl	167	50
2	<i>p</i> -Hydroxybenzaldehyde	.. 2'-( <i>p</i> -Hydroxyphenyl)	269	50
3	Anisaldehyde	.. 2'-( <i>p</i> -Anisyl)	171	55
4	<i>m</i> -Nitrobenzaldehyde	.. 2'-( <i>m</i> -Nitrophenyl)	121	40
5	2 : 4-Dichlorobenzaldehyde	.. 2'-(2 : 4-Dichlorophenyl)	124	50
6	Vanillin	.. 2'-(3-Methoxy 4-hydroxy phenyl)	114	55
7	<i>p</i> -Dimethylaminobenzaldehyde	.. 2'-( <i>p</i> -Dimethylaminophenyl)	174	50
8	2-Ethoxy 1-naphthaldehyde	.. 2'-(2-Ethoxy 1-naphthyl)	102	50
9	9-Anthraldehyde	.. 2'-(9-Anthryl)	139	50

\* All the oxazoles are reported for the first time.

2'-Methyl coumarino-(3 : 4) oxazole<sup>8</sup> was prepared by condensing II with acetic anhydride. The coumarino-(3 : 4) oxazoles (IV) have been obtained by refluxing 3-amino 4-hydroxy coumarin hydrochloride (II) with an aromatic aldehyde in nitrobenzene. The use of nitrobenzene in the condensation is based on the fact that it

All these compounds have been tested for bacteriostatic and fungistatic properties. Compounds which have shown appreciable activity against bacteria and fungi are 2'-(3-methoxy 4-hydroxy phenyl) coumarino-(3 : 4) oxazole, 2'-(*p*-dimethylaminophenyl) coumarino-(3 : 4)-oxazole, 2'-(2-ethoxy 1-naphthyl) coumarino-

(3:4) oxazole, and 2'-(9-anthryl) coumarino (3:4) oxazole. The N-substituted 3-amino 4-hydroxy coumarins are not active against bacteria but some of them have shown appreciable fungistatic activity. The compounds which have shown appreciable fungistatic activity only are 3-(p-acetamidophenyl) 4-hydroxy coumarin, 3-(p-diphenylamino) 4-hydroxy coumarin, 2'-(p-anisyl) coumarino-(3:4) oxazole and 2'-(2:4-dichlorophenyl) coumarino-(3:4) oxazole.

Full details of the method of preparation as well as the physiological data and the spectra will be published later. One of the authors (K. S. R.) is indebted to the C.S.I.R. for the award of a Junior Fellowship.

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Chemistry Dept., N. V. SUBBA RAO.

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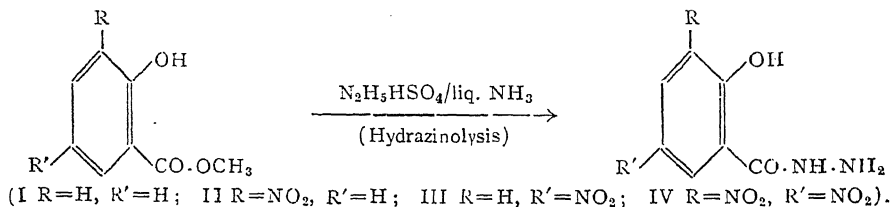


TABLE I

S. No.	Hydrazides	Crystalline nature	Yield %	M.P. - °C.	Nitrogen		Solvents for crystallisation
					Found %	Calculated %	
I	Salicylhydrazide	.. White needles	73	146	18.29	18.42	Ethanol
II	3-Nitrosalicylhydrazide	.. Yellow needles	67	200 (decomp.)	21.84	21.32	Dioxon/H <sub>2</sub> O (9:1)
III	5-Nitrosalicylhydrazide	.. Yellow rhombic crystals	74	178 (decomp.)	21.71	21.32	Hot H <sub>2</sub> O
IV	3:5-Dinitrosalicylhydrazide	.. Yellow needles	65	235 (decomp.)	23.03	23.14	Hot H <sub>2</sub> O

shaken and kept aside for a week at room temperature. The ammonia was removed and the residues were washed with a little of ethanol and a good amount of ice-cold water and dried giving the corresponding salicylhydrazides.

The hydrazides prepared by this method are given in Table I.

The author is grateful to Dr. C. N. Haksar, Director, Jiwaji Industrial Research Laboratory, Gwalior, for his valuable suggestions.

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#### A NOTE ON THE OCCURRENCE OF MANGANESE TABLOIDS AND BOUDINAGES IN THE ARAVALLI PHYLLITES OF BAMANKUA AND SHIVRAJPUR, GUJARAT

THE author, during the course of his recent field investigations of the manganese bearing horizon of Shivrajpur (22° 26' : 73° 37') and Bamankua (22° 27' : 73° 37'), Panch Mahals, Gujarat, came across some manganese tabloids and boudinages in the Aravalli manganese phyllites of the above-mentioned localities. These tabloids and boudinages appear to have an important bearing on the genesis of the manganese ores of the area. The previous workers, *viz.*, Fermor,<sup>1</sup> Beer,<sup>2</sup> and Roy,<sup>3</sup> who briefly described the manganese ores of Shivrajpur and Bamankua, did not, however, record these structures.

The tabloids and boudinages of manganese were found in the same phyllite horizon of Bamankua and Shivrajpur, which forms a part of the Aravalli succession of Panch Mahals and Baroda districts and which was further proved to be of sedimentary origin (Rasul<sup>4</sup>). The phyllite is often intermixed with lithomarge, slate and shale, and sometimes interbedded with quartzite. Large workable deposits of manganese ores are associated with the phyllite of Shivrajpur, Bamankua and a few other adjacent localities.

Some tabloid-like masses, resembling wad in appearance, were encountered in a variety of milk-white lithomargic phyllite in the southern section of the Bamankua mines. The phyllite is moderately foliated and more or less hard and compact. The tabloids are soft and composed of an intimate mixture of manganese oxides and some earthy matter, due to which they look dark-brown in colour and they do not show any evidence that may suggest their introduction into the phyllites by replacement. The tabloids, which are greatly flattened and elongated in the direction of foliation of the phyllite, have acquired biconvex shape with sharp edges. The length of the individual tabloids, measured along their major diameters, varies from 1-3 cm., and their thickness does not exceed 1 cm. An interesting feature of these tabloids is their *en echelon* arrangement in the host rock (Fig. 1). On account of their regular form and weak cohesion, the tabloids can be easily dislodged from the phyllites leaving their smooth and well-defined moulds in the latter.



FIGS. 1-2. Fig. 1. A handspecimen of manganese tabloids (black) in white lithomargic phyllite.  $\times \frac{1}{3}$  Nat. Size. Fig. 2. A handspecimen of rod-like manganese boudins (black) in phyllite,  $\times \frac{1}{3}$  Nat. Size.

The manganese boudinages were recorded from a white and fine-grained variety of phyllite in the south Shivrajpur mines. Longitudinally, the boudins are rod-like in shape and transversely, they are somewhat elliptical, the major diameter measuring about 1 cm. The boudins are closely spaced and have their lengths

parallel to the foliation of the phyllite enclosing them (Fig. 2). The boudins are sharply defined from one another but have much structural conformity with respect to the phyllite deformation, both being affected by jointing and even minor buckling.

Available evidence suggests that the manganese tabloids and boudinages have syngenetic relation with Aravalli phyllites and that they were originally laid down as nodules and thin laminations of low temperature manganese oxides along with the pelitic sediments that were ultimately transformed into phyllite by partial metamorphism and the manganese ores, being more competent than the phyllite, were stretched into tabloids and rod-like boudinages.

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S. H. RASUL.

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#### SULPHUR ISOTOPE STUDIES OF SULPHIDE MINERALS FROM THE MOSABONI COPPER MINE, BIHAR

As a part of the research programme aimed at studying the genesis of sulphide ores of the Mosaboni copper mine (Long.  $86^{\circ} 28' E.$ ; Lat.  $22^{\circ} 31' N.$ ), an attempt is made to investigate the possibility of using sulphur isotopic abundances ( $S^{32}/S^{34}$  ratio) in sulphide ores in sheared soda granite as an additional aid in the study of the problem. The sulphide minerals, pyrrhotite, pyrite and chalcopyrite, of different generations and from different levels were separated by hand-picking from the associated gangue and other ore minerals. The purity of the samples is practically 100%. The techniques of chemical processing and estimation of isotopic composition of sulphur are substantially the same as those reported by Jensen.<sup>1</sup> Isotopic ratios are reported (in terms of variation in parts per thousand  $\delta$ , ‰) relative to the primary standard, Canyon Diablo troilite, whose  $S^{32}/S^{34}$  ratio is assumed to be 22.21.<sup>2</sup> Positive and negative  $\delta$  values indicate respectively heavier and lighter sulphur than that of meteoritic troilite.

The nature of the mineral, location and  $\delta S^{34}$ , ‰ are given in Table I.

TABLE I

Sl. No.	Mineral	Location			$\delta S^{34}$ , %
		Level No.	Drive (N. or S.)	Distance in feet from drive	
1	Pyrrhotite (second generation)	16	S	3200	+4.4
2	Pyrite (first generation)	10	S	3300	+3.3
3	Chalcopyrite (third generation)	16	S	3200	+4.3

The values given in Table I are uniform enough and close enough to zero per mil. so as to indicate a single source of supply of sulphides and a magmatic hydrothermal mode of genesis for sulphides. This conclusion is consistent with the earlier inference of the author<sup>3,4</sup> (based upon trace element constitution) that the sulphide ores and soda granite are genetically related—a view favoured by Dunn<sup>5</sup>—and that the chemical composition of ore-bearing solutions remained roughly the same throughout the history of crystallisation.

The author is grateful to Professor M. L. Jensen of Yale University for kindly making the isotopic analysis of sulphur and for helpful advice.

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#### FUNCTIONAL MORPHOLOGY OF THE STOMACH OF *CAPRELLA LINEARIS* (L.)

*Caprella linearis* (L.) of the family Caprellidae can be easily recognised by its long slender body. Several observers have maintained that they feed on hydroids and algæ. In the laboratory, they can be fed on a variety of materials such as meat, mashed up crustacea and bread soaked in meat juice. According to Harrison,<sup>1</sup> they feed on copepods and nauplii. *Caprella* are found below the low water mark, attached by their pleopods to the less dense forms of hydroids, algæ, bouys, floating wreckage, etc.

The alimentary canal of *Caprella* consists of the foregut, midgut and hindgut. The foregut includes the mouth, œsophagus and stomach,



The stomach is divisible into an anterior 'cardiac' and posterior 'pyloric' stomach. The inner wall of the cardiac stomach (Fig. 1) is

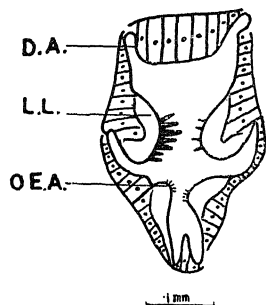


FIG. 1. *Caprella linearis*. T.s. of the cardiac stomach. D.A., dorsal ridge; L.L., lateral ridge; O.E.A., oesophageal ridge.

produced into complicated series of chitinous plates and ridges, provided with teeth, hairs, spines or hooks. These include a median dorsal ridge (D.A.), paired lateral ridge (L.L.)—each bearing 9 strong curved teeth, paired ventro-lateral ridges (Fig. 2, V.L.) with long spines and a pair of dorso-lateral ridges (D.L.). Thus the cardiac stomach is incompletely divisible into a small dorsal, a large middle and a narrow ventral portion.

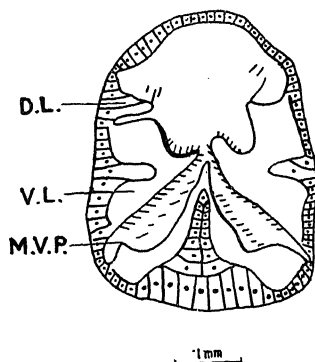


FIG. 2. T.s. of the pyloric stomach. D.L., dorso-lateral ridge; M.V.P., mid-ventral piece; V.L., ventro-lateral ridge.

The cavity of the pyloric stomach (Fig. 2) is divisible into a dorsal chamber, leading directly from the cardiac stomach into the midgut, and the ventral chamber reduced to two narrow pyloric grooves by the presence of a long mid-ventral piece (M.V.P.) which bears a large number of small spines distally. It has three protuberances on the two sides which are produced into long spines.

The functions of the crustacean stomach have been described by various authors. Huxley,<sup>2</sup>

Gelder,<sup>3</sup> etc., pointed to the masticatory function of the cardiac stomach and that the pyloric stomach acts as a strainer. Tait,<sup>4</sup> and Nicholls,<sup>5</sup> denied any such functions to the stomach of any crustacea.

However, looking to the structure of the cardiac stomach, provided as it is with spined or toothed ridges and plates and the pyloric stomach armed with clusters of fine bristles the author is convinced that in *Caprella linearis* the cardiac stomach acts for the trituration of the larger food particles which then pass into the pyloric stomach; this latter allows only smaller food particles to pass into the midgut, where they are digested and absorbed. The similar condition has been found in *Corophium volutator* (Agrawal<sup>6</sup>).

The author is indebted to Prof. J. E. Smith, F.R.S. of London University, for his guidance.

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#### FIXATION OF ELEMENTARY NITROGEN BY SCYTONEMA HOFMANNI AG. EX BORN. ET FLAH. AND FISCHERELLA MUSCICOLA (THURET) GOMONT IN PURE AND UNIALGAL CULTURES

SEVERAL blue-green algae are known to fix elementary nitrogen and many of them grow in abundance in the rice fields. During a study of the algae of rice fields of India and their contribution to the fertility of the soil, we isolated and prepared unialgal cultures of *Scytonema hofmanni* Ag. ex Born. et Flah. and *Fischerella muscicola* (Thuret) Gomont. These were obtained in pure bacteria-free cultures by a method similar to that used by Gerloff *et al.* (1950), i.e., by ultra-violet irradiation and streaking on silica gel plates impregnated with nitrogen-free De's (1939) solution.

Purity of the cultures was tested with Peptone solution (1%); Glucose (0.5%) and Peptone (1%) solution; Meat extract ("Oxo Lablemco") solution (1%) and De's liquid medium containing  $\text{KNO}_3$  and Glucose (0.5%). Absence of

turbidity in all the replicates was taken as the criteria for purity of cultures from bacteria. Such tests were performed before inoculations and also at the end of the experiment.

Bacteria-free and unialgal cultures of *Scytonema hofmanni* and *Fischerella muscicola* were grown in 250 ml. Erlenmeyer flasks containing 100 ml. De's medium without the nitrogen salts but with addition of Hutner's (1950) micro-nutrient solution which was modified by replacing  $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}$  with  $\text{MoO}_3$  in order to make it nitrogen-free. Initial pH of the solution was adjusted to 7.0.

Inoculations were made from a healthy culture with the help of an inoculum cutter. The cultures were grown under continuous light (180 Lux) at 28°–30° C. The cultures were harvested after 35 day's growth. The purity of cultures was tested again from each flask by the methods given above before harvesting. The algal mat and filtrate were separated by centrifugation for analysis of nitrogen content. The dry weight of the algal mat was taken only from pure cultures by filtration through preweighed Whatman filter-paper (No. 42). Nitrogen analyses were made by the method of Humphries (1956). The results obtained are shown in Table I and represent averages of three replicates.

The amount of nitrogen fixed in our experiment is not much, under the present cultural conditions, yet these forms are shown to possess the undoubted ability to fix elementary nitrogen and if given appropriate conditions may also prove to be good fixers. The results with our cultures show that, although the nitrogen in algal mat is generally low, considerable amount of nitrogen is found in the culture filtrate.

Fuller *et al.* (1960) reported nitrogen fixation in some blue-green algæ, isolated from desert soils of Arizona. The fixation of nitrogen was seen in algal crust and algæ in pure cultures and mixed cultures. However, no mention is made of the purity of algæ from bacteria other than *Azotobacter*, volume of basal nutrient solution used for growing the algæ and incubation period. The percentage of total nitrogen fixed in *Scytonema hofmanni* B and F, reported by them, is 5.70% which is nearer to the value of 3.89% noted in our bacteria-free culture of the same species.

This work was carried out under a PL-480 scheme financed by the United States Department of Agriculture to whom the authors wish to express their appreciation and thanks.

Botany Department, V. K. LALORAYA.  
Allahabad University, A. K. MITRA.  
Allahabad (India), June 23, 1964.

TABLE I  
Showing amount of nitrogen fixed in 35 days in pure and unialgal cultures of *Scytonema hofmanni* Ag. ex. Born. et Flah. and *Fischerella muscicola* (Thuret) Gom.  
per 100 ml. culture solution

Forms		Dry weight in mg.	Amount of nitrogen fixed in mg.			nitrogen fixed as % of dry wt.
			In algal mat less in inoculum	In filtrate	Total	
<i>Scytonema hofmanni</i>	Bacteria-free culture	18.7	0.3195	0.4080	0.7275	3.89
	Unialgal culture		0.5461	0.3732	0.9193	
<i>Fischerella muscicola</i>	Bacteria-free culture	25.0	0.0630	0.4232	0.4862	1.95
	Unialgal culture		0.1810	0.4000	0.5810	

From the above results it is seen that *Scytonema hofmanni* and *Fischerella muscicola* members of Scytonemataceæ and Stigonemataceæ respectively have the capacity to fix elementary nitrogen and that nitrogen fixation in unialgal cultures, i.e., algal cultures in normal association with bacteria, is greater than that in bacteria-free cultures. In recent years such cases have also been reported by Bunt (1961) and Bjälfve (1962). It is difficult to say at this stage whether the increase is due to the fixation of nitrogen by the bacteria also or it is the association of bacteria which somehow promotes the nitrogen fixing capacity of the blue-green algæ.

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# MODES OF FORMATION OF DIPLOID MEGAGAMETES IN *SACCHARUM*

NARAYANASWAMY<sup>1</sup> was the first to report on the mode of diploidisation of megagametophytes in *Saccharum*. According to him in the variety Vellai fusion of the nuclei of the third megaspore cell and the chalazal cell takes place resulting in the formation of diploid gametes. Bremer<sup>2,3</sup> felt from extensive study of the megasporogenesis of hybrids raised in Java, that, though nuclear fusion may not be excluded "to ascribe the origin of so many seedlings with increased chromosome number to nuclear fusion, a phenomenon, that was lacking or at the most extremely sporadic, should be absurd". According to him endoduplication in the chalazal cells of the tetrad results in the formation of  $2n$  gametes and "it seems rather improbable that the chromosome doubling in the female generative cell, a phenomenon especially known to occur in great quantities in sugarcane, should happen in two totally different ways". Sam Price<sup>4</sup> felt that "the reality of post-meiotic endomitosis still calls for independent confirmation".

Investigations on the megasporogenesis of two complex hybrid varieties raised at this Institute, Co. 421 and Co. 603, have revealed certain interesting points in this connection which are presented below:

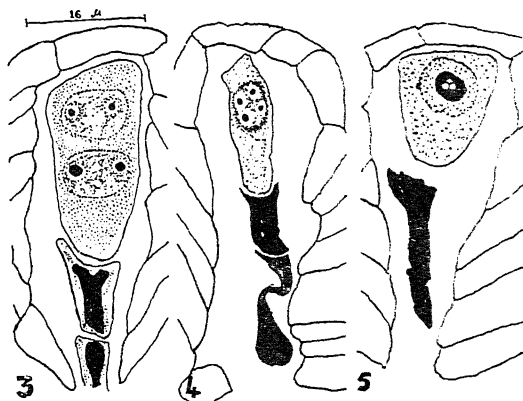
In Co. 421, a dyad of megaspores is produced after the first meiotic division. The micropylar dyad completes the second meiotic division and the resulting spores degenerate while the chalazal dyad nucleus completes the second meiotic division producing two megaspores both of which develop further (Fig. 1). Cell walls separating these two haploid megaspore nuclei are rarely formed and when so are disorganised rapidly. The spore nuclei migrate either to the centre of the cell (Fig. 3) or towards the chalazal end of the topmost cell where they remain close to each other. Later the fusion of these two haploid nuclei results in a diploid fusion nucleus (Figs. 4 and 5). This fusion nucleus has one or more nucleoli. This is the situation in 100% of the cases.

In the clone Co. 603, a linear tetrad of megaspores is formed after the completion of meiosis (Fig. 2). The three outermost megaspores degenerate while the chalazal one develops after a short interphase. It has not been possible to count the chromosomes of the megagametophyte mother cell. However, since the chalazal megaspore is haploid, the diploidisation of the megagametophyte is inferred to be brought out

by endoduplication of the chromosomes. This is the position in all the cases.



FIGS. 1-2. Fig. 1. L.s. through the ovule of Co. 421. Binucleate chalazal megaspore and two degenerating spores. Fig. 2. L.s. through the ovule of Co. 603. A linear tetrad of megaspores out of which the chalazal one is the functional and the three micropylar spores are degenerating.



FIGS. 3-5. L.s. through the ovule of Co. 421 showing the developmental sequences in the formation of diploid megagametophyte mother cell. Fig. 3. Binucleate chalazal megaspore and two degenerating spores. Fig. 4. Fusion of the two megaspore nuclei and the degeneration of the two chalazal megaspores. Fig. 5. Fusion nucleus (Diploid megaspore).

The above observations indicate that diploidisation of the megagametophyte in *Saccharum* may be either due to fusion of the nuclei of the innermost haploid megaspores or through endoduplication of the chromosomes of the chalazal megaspore. How far this is a varietal character and genotypically controlled is under investigation.

Thanks are due to the Director of the Institute for suggesting this work and to Shri M. R. Venkatraman for supply of material.

Sugarcane Breeding Inst., M. P. ALEXANDER.  
Coimbatore-7, June 26, 1964.

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2. Bremer, G., *Proc. VIII Int. Congr. Genetic Suppl. Hereditas*, 1949, p. 541.
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### STAURONEMA INDICUM SP. NOV. FROM INDIA

AMONG the mycological collections recently made by the writer was an interesting Sphærospideaceous fungus obtained on dead wood of *Lawsonia alba* L., a common hedge plant

Sydow and Butler (1916) to the genus *Stauronema* Syd. and Butl. Since then, three species have been described in this genus, all on Monocots, two of which have been reported, from Gramineous hosts, viz., *S. sacchari* Syd. and Butl. and *Stauronema cruciferum* (Ellis) Syd. and Butl., the former from India. Recently Roy and Dwivedi (1962) obtained an undetermined species of this fungus on *Vetivera zizanioides* Nash. a grass host. Veeraraghavan et al. (1963) have reported *S. sacchari* on *Oryza sativum* L. from South India. The collection made by the writer on *Lawsonia alba* L. was thus of special interest. This is the first report of the occurrence of this fungus genus on a Dicot. A critical comparative study was, therefore, undertaken between the writer's collection and the other known species of *Stauronema* with the results given in Table I.

TABLE I

Species	Host	Pycnidial setæ	Pycnidiospores	Conidial appendages	Authority
<i>S. cruciferum</i> (Ellis) Syd. and Butl.	Grass host	75-85 $\mu$	7.5-8.5 $\times$ 3-4 $\mu$	..	Sydow and Butler (1916)
<i>S. platense</i> (Speg.) Syd. and Butl.	<i>Sciops</i> sp.	60-100 $\times$ 6-8 $\mu$	15 $\times$ 4-5 $\mu$	15 $\times$ 1 $\mu$	do.
<i>S. sacchari</i> Butl.	<i>Saccharum officinarum</i> L.	70-135 $\times$ 6-9 $\mu$	10-12 $\times$ 3 $\mu$	10-12 $\times$ 1 $\mu$	Butler (1916)
<i>S. species</i>	<i>Lawsonia alba</i> L.	50-500 $\times$ 2-4 $\mu$	10.5-21 $\times$ 4.5-5.0 $\mu$	17-25 $\times$ 1.5-2.4 $\mu$	Kalani

from the campus of Agriculture College, Poona. The fungus produced numerous superficial black pycnidia, characteristically cupulate and setose provided with numerous black stiff setæ all over the body with appendaged star-shaped pycnidiospores, characteristic of the form-genus *Stauronema* Syd. and Butl.

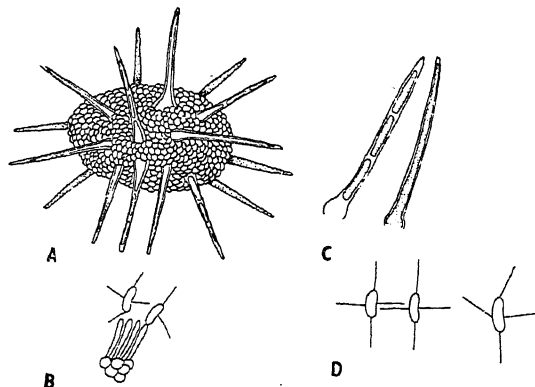


FIG. 1. *Stauronema indicum* sp. nov. Kalani. A, Pycnidium,  $\times$  100; B, Conidiophores and conidia,  $\times$  440; C, Pycnidial setæ,  $\times$  264; D, Pycnidiospores,  $\times$  440.

Pycnidial fungus originally considered as a sub-genus of *Dinemasporium* was transferred by

A careful perusal of the tabular statement would show that the writer's collection is significantly distinct from all the known species in respect of all the characters possessing much longer and thinner pycnidial setæ, bigger pycnidiospores and much longer conidial appendages besides being collected on a Dicot host.

The fungus, therefore, is offered as a new species of *Stauronema* with Latin diagnosis.

#### *Stauronema indicum* Sp. Nov. KALANI

Pycnidia superficialia, amphigena, dispersa, interdum aggregata, rotunda setosa, discoidea vel applanata, fusce brunnea vel nigra 0.24-2.8 mm. Steæ rectae vel paulum curvatae, rigidae, non-numquam basi bulbosa imatae, e fusce brunneis nigræ ad basin, hyalinae vel pallide brunneæ at apicem, non-numquam 2-3 septatae, vulgo non septatae, parietibus duplicibus, leves, 50-500  $\mu$ . Conidiophora simplicia, hyalina disposita per totos cavitatis parietes, 21-42  $\times$  1.5-2.1  $\mu$ . Conidia hyalina, lunata vel oblonga, 10.5 to 21  $\times$  4.5-5  $\mu$  recta vel curvata, vulgo appendicibus quaternis raro ternis ornata, appendicibus una ad utrumque apicem, et una ad utrumque latus conidii ad medium, 17-25  $\times$  1.5-2.4  $\mu$ . In culmis emortuis *Lawsoniae albæ* L.

leg. dna. I. K. Kalani mense octobri anni 1963, ad Poona, M.A.C.S. No. 175 (Type).

This is the second species of this rare genus reported from India and the first known species on Dicot host.

Grateful thanks are due to Prof. M. N. Kamat for his guidance, to Dr. S. Santapau for Latin rendering, to the Director, M.A.C.S., for facilities, and to the C.S.I.R. for the award of a fellowship.

M.A.C.S. Laboratories, MISS I. K. KALANI.  
Poona-4, May 7, 1964.

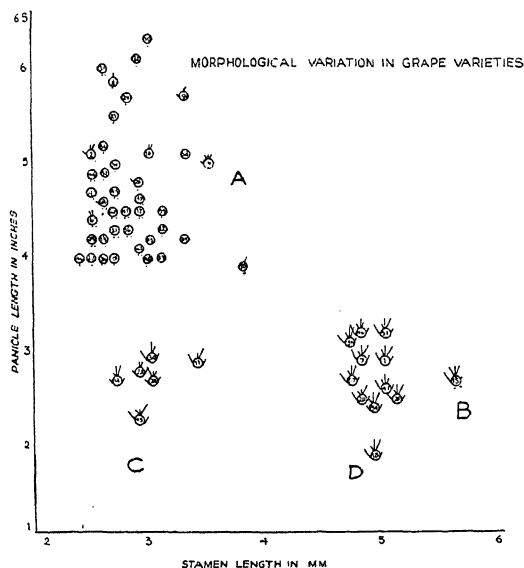
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#### APPLICATION OF ANDERSON'S POLYGRAPH ANALYSIS IN GRAPES

TECHNIQUES are now available for drawing inferences concerning phylogenetic trends from an analysis of the phenotypic traits. One such method is the presentation of morphological data in the form of a pictorialised scatter diagram standardised by Anderson.<sup>1</sup> This method involves the pictorial depiction of character associations and the quantitative scatter for different traits. It provides a simple but reliable way of studying the extent of introgression of genes from one species to another and the value of such a tool has been elegantly demonstrated in many plant genera (see Stebbins<sup>2</sup>). No attempt seems to have been so far made in grapes to assess the utility of this method. The origin of many of our cultivated grape varieties is unknown and suggestions made by different workers in the field are largely speculative. Most of the grape taxonomists have focussed their attention mainly on the morphological description of the cultivated varieties. A study was hence taken up on 58 varieties of grapes grown at the Division of Horticulture, Indian Agricultural Research Institute, New Delhi, using the pictorialised scatter diagram method. Cytological studies were also made in some of these varieties since such studies in conjunction with morphological data would provide much insight into the nature of origin and differentiation of grape varieties.

A study of the morphological diversity in these varieties revealed that the variations could be critically estimated by the following seven

characters: (i) stamen length, (ii) panicle length, (iii) peeling of bark (easy, moderate, not peelable), (iv) tomentum on leaves (absent, sparse, dense), (v) number of leaf lobes (three, five, three and five), (vi) adherence of skin to pulp (adhering, slip-skin) and (vii) time of fruit-ripening (early, mid-season, late). Of these characters, the first two were chosen for X and Y axis of the scatter diagram and the rest of the characters were represented by drawing rays of different length at different positions as suggested by Anderson.<sup>1</sup> The scatter diagram prepared thus (Fig. 1) showed a clumping



Key: *Bark* (○ not easily peelable, ○ moderately peelable, ○ easily peelable), *Tomentum* (○ absent, ○ sparse, ○ dense), *Leaf lobes* (○ five, ○ three and five, ○ three), *Adherence of skin to pulp* (○ adhering, ○ slip-skin), *Fruit ripening* (○ early, ○ mid-season, ○ late), *Pollen fertility* (○ low, ○ medium, ○ high)

A-V. *vinifera* B-V. *labrusca* C and D-Hybrids

FIG. 1

of varieties into four groups, two of which occupied the extreme positions (one on either side) of the diagram and the rest of the two occupying middle positions. Of the first two groups, one showed predominantly the characters of *Vitis labrusca* and the other of *V. vinifera*. The other two groups showed various reassortment of the characters of these two groups (species) which along with the relative positions they occupied in the diagram suggested that varieties of these groups are of hybrid origin. These groups also included some of the varieties which are known to be hybrids involving *labrusca-vinifera* parentage.

A meiotic study was undertaken in some varieties of each of these groups. While meiosis was mostly normal in the varieties of the first two groups, abnormalities were observed during all stages of meiosis in the other two. Varying numbers of univalents were recorded at diakinesis and metaphase I. Anaphase I and II stages were marked by the presence of laggards (Fig. 2). At the sporad stages, the presence of one or more micro-nuclei was also observed (Fig. 3) which accounts for the high pollen

Swaminathan, Head of the Division of Botany, for their keen interest in this study. The senior author is thankful to the Council of Scientific and Industrial Research for the award of a fellowship.

Division of Horticulture,  
Indian Agricultural  
Research Institute,  
New Delhi, July 27, 1964.

C. P. A. IYER.  
G. S. RANDHAWA.



FIGS. 2-3. Meiotic abnormalities in the hybrid groups. Fig. 2. Anaphase I showing laggards. Fig. 3. One micronucleus.

sterility observed in these varieties. Thus, cytological studies indicated that while meiosis was generally regular in the varieties belonging to one or the other species several irregularities and consequently varying degrees of pollen sterility occur in those which are of hybrid origin. The meiotic behaviour is in conformity with the position revealed by the scatter diagram and this method of character analysis can hence be exploited with profit to trace the ancestry of grape varieties of unknown origin.

We are indebted to Dr. S. K. Mukherjee, Head of the Division of Horticulture and Dr. M. S.

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### *CERCOSPORA LONGISSIMA* CUGINI EX TRAVERSO ON LETTUCE—A NEW RECORD FOR INDIA

DURING January, 1964, a severe leaf-spotting of lettuce (*Lactuca sativa* L.) was observed at the Government Vegetable Research Farm, Kalyanpur (Kanpur). The disease was characterised by minute water-soaked specks, gradually enlarging into sub-circular to angular, amphigenous leaf-spots, 1-6.5 mm. in diameter but often coalescing to form bigger blotches up to 27.5 mm. in diameter. The pin-head points were tawny-olive in colour but well-developed spots had a mummy-brown border with smoky-grey to pale-pinkish-buff centre. The fruiting was amphigenous.

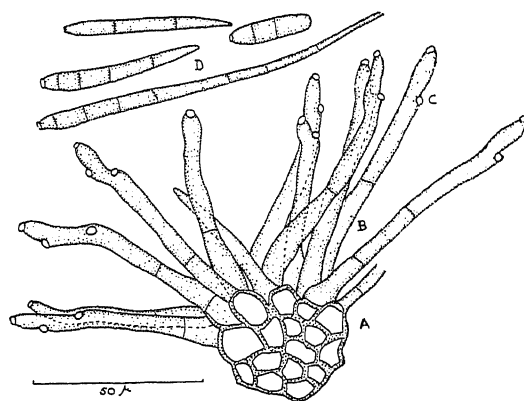


FIG. 1. A. stroma; B. conidiophore; C. geniculation; D. conidia.

*Morphology of the Fungus.*—Stroma globular to somewhat irregular, antimony-yellow to ochraceous-tawny in colour, 22.66-60.45  $\mu$  in diameter, compact; conidiophores in fascicles of 6-30 or more, indistinctly 0-2 septate, abruptly 0-2 geniculate, somewhat attenuated above each

geniculation, tip sub-truncate, straight to mildly curved, uniformly ochraceous-buff in colour with warm-buff contents,  $17.27-108.5 \times 3.23-5.39 \mu$ ; conidia hyaline, usually acicular or obclavate, indistinctly multiseptate, straight to curved, tip round to sub-acute, base truncate to sub-truncate,  $13.11-194.31 \times 3.22-4.31 \mu$  in size.

In its diagnostic features, this fungus resembles Chupp's<sup>1</sup> description of the Italian collection of *Cercospora longissima* which differs from our collection in having a larger stroma and conidiophores spread over both sides of leaves. In the Italian collection the conidiophores were mostly epiphyllous. Munjal *et al.* reported *C. longissima* var. *indica* var. nov. on *Lactuca* sp. from Pusa (Bihar), with no geniculations on conidiophores and conidia measuring  $19-77 \times 5-8 \mu$ . Our fungus markedly differs from it in having dense, larger and globose stroma, up to 2 geniculations on conidiophores, which are somewhat attenuated above each geniculation and very much larger conidia. *C. longissima* is reported from Italy, Puerto Rico, Philippines, Colombia, Formosa, Tanganyika Territory, Sudan, Zamorano, Jamaica, South Leone, Nyasaland, Mauritius. So far as known this is the first record of this fungus in India.

Thanks are due to Mr. F. C. Deighton of the Commonwealth Mycological Institute, Kew, Surrey, England, for confirming the identification (IMI Accession No. 104804).

Section of the Plant	R. S. MATHUR.
Pathologist to Government,	D. V. SINGH.
Uttar Pradesh,	S. N. PRASAD.
Kanpur, May 7, 1964.	

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#### A NEW HOST OF *CERCOSPORA* SP.— *BURSERA DELPECHIANA* POISSON

*BURSERA*, a native of Mexico, was introduced over thirty years back into India where, after trials in several parts of the country, it was successfully established in the Mysore State and is presently cultivated over fairly extensive areas. *Bursera* is the source of Linaloe oil which is distilled from the husk of the berries.

*Bursera* is under cultivation in the CIMPO Experimental Farm near Devanahalli. When the plants are a year old, yellow areas in the apical

region of the leaf appear. These areas gradually enlarge irregularly and cover almost half of the leaf-blade. The infected areas turn dark brown in colour and the disease spreads rapidly in moist weather though little damage is caused to the host. The spots, however, are not vein-limited.

The mycelium is endophytic and the conidiophores emerge in groups through the stomata on both sides of the leaf. There is a large number on the lower surface. The conidiophores are mostly unbranched, light brown in colour and conical at the tip. The conidia are hyaline to pale brown and long with 2-3 cross-walls.

In structural details the species under report bears resemblance to *Cercospora ocimicola* Petrak *et* Ciferri but differs in the length of the conidia, septate nature and the truncated appearance of the conidia tip. The form under report is a new species and *Bursera* is a yet unreported host. Specimens have been sent to the Commonwealth Mycological Institute, Kew, for identification (IMI-106602).

Grateful thanks are due to Dr. M. N. Ramaswamy for his encouragement and guidance.

Central Indian Medicinal Plants Organisation,  
Mohamed Sarwar,  
Bangalore, June 5, 1964.

#### SOME NEW STORAGE DISEASES OF FRUITS AND VEGETABLES

Due to great loss inflicted by fungi to the vegetable and fruit industry, the authors were prompted to undertake systematic work on the storage of fruits and vegetables. During six months from November 1963 to April 1964 a large number of such fungi were isolated. In the present paper only those diseases have been described which have, hitherto, not been reported from India. They have also not been incorporated in any of the published lists of Indian fungi.<sup>1-5</sup> The pathogenicity of the various organisms was tested. A few of them marked with (‡) were not parasitic.

A summarised account of the diseases included in this paper is given in Table I. Detailed investigation on some of the diseases will be published elsewhere.

The authors are thankful to the University Grants Commission for awarding Junior Research Fellowship to one of them (A. V.).

TABLE I

No.	Host	Incitant	Symptom
1	<i>Artocarpus heterophyllus</i> (Vern. Kathal)	<i>Alternaria tenuis</i> Nees	Black spots on fruits
2	<i>Azerrhoa carambola</i> (Vern. Kamrakh)	do.	Large hair brown spots on fruits
3	<i>Brassica oleracea</i> var. <i>botritis</i> (Vern. Phulgobhi)	* <i>Botryodiplodia theobromae</i> Pat. <i>Fusarium</i> sp.	do. Rotting of the flowers developing vinaceous buff shade
4	<i>Brassica oleracea</i> var. <i>gongiloides</i> (Vern. Ganth-gobhi)	<i>Colletotrichum</i> sp.  <i>Alternaria circinans</i> (Berk. and Curt.) Bolle	Dark olive gray spots on tuberous stem  do.
5	<i>Canavalia ensiformis</i> (Vern. Bari Sem)	<i>Fusarium</i> sp. <i>Alternaria tenuis</i> Nees	Rotting of fruits. Oval spots of dark grayish olive colour on fruits
6	<i>Capsicum frutescens</i> (Vern. Mirch)	† <i>Melanospora damnosa</i> (Sacc.) Lind.	Iron gray spots on fruits
7	<i>Citrus decumana</i> (Vern. Chakotra)	<i>Helminthosporium</i> sp.  <i>Phoma</i> sp. <i>Curvularia lunata</i> (Wakker) Boedj.	Large spots of cinnamon drab colour on fruits do. Large irregular spots of deep brownish drab colour on fruits
8	<i>Citrus medica</i> (Vern. Neembu)	† <i>Cladosporium herbarum</i> (Pers.) Link	do.
9	<i>Daucus carota</i> (Vern. Gazar)	<i>Phoma</i> sp.	do.
10	<i>Dioscorea alata</i> (Vern. Ratalu)	<i>Fusarium</i> sp. <i>Botryodiplodia theobromae</i> Pat.	Rotting of roots do.
11	<i>Dolichos lablab</i> (Vern. Sem)	<i>Fusarium</i> sp.  <i>Alternaria tenuis</i> Nees  <i>Curvularia trifolii</i> (Kauffin) Boed. <i>Nigrospora sphaerica</i> (Sacc.) Mason <i>Phoma</i> sp. † <i>Chaetomium globosum</i> Kunze and Schm. † <i>Cladosporium herbarum</i> (Pers.) Link	do. do. do. Large spots of deep quaker drab colour on fruits Irregular spots of iron gray colour on fruits Rotting of fruits from sides Small black spots on fruits Deep brownish drab spots on fruits do.
12	<i>Abelmoschus esculentus</i> (Vern. Bhindi)	<i>Helminthosporium nodulosum</i> (Berkeley and Curtis) Sacc. † <i>Cladosporium</i> sp.	Rotting of fruits Black spots and rotting of fruits
13	<i>Ipomoea batatas</i> (Vern. Shakarkand)	<i>Fusarium</i> sp. <i>Botryodiplodia theobromae</i> Pat.	Purple drab oval spots on fruits Brown spots and hard internal tissue of sepia colour of roots
14	<i>Lagenaria leucantha</i> (Vern. Lauki)	<i>Fusarium semitectum</i> Berk. et Rav. <i>Phoma</i> sp. <i>Alternaria circinans</i> (Berk. and Curt.) Bolle	Rotting of fruits Stem end rot do.
15	<i>Luffa cylindrica</i>	† <i>Curvularia</i> sp. <i>Alternaria tenuis</i> Nees	Mars brown irregular spots on fruits
16	<i>Lycopersicon esculentum</i> (Vern. Tamatar)	<i>Pestalotia</i> sp. <i>Phoma</i> sp. † <i>Trichothecium roseum</i> Link ex Fr.  * <i>Alternaria tenuis</i> Nees † <i>Melanospora damnosa</i> (Sacc.) Lind. <i>Peyrothella nainiensis</i> Tan. et Bil.	Rotting of fruits do. Fruits showing small circular spots with iron gray outlines Elongated spots with olive gray out- lines on fruits Black spots with zonations on fruits Iron gray spots on fruits
17	<i>Momordica charantia</i> (Vern. Karela)	† <i>Septocylindrium</i> sp. <i>Fusarium</i> sp.	Crackings on fruits in the form of semicircular rings near the calyx
18	<i>Phyllanthus emblica</i> (Vern. Amla)	<i>Cytospora</i> sp.  † <i>Cladosporium herbarum</i> (Pers.) Link	Deep mouse gray spots on fruits Rotting of fruits Small spots of ochre red colour on fruits
19	<i>Pisum arvense</i> (Vern. Desi Matar)	<i>Curvularia lunata</i> (Wakker) Boedj <i>Colletotrichum gloeosporioides</i> Penzig <i>Gloeosporium</i> sp. <i>Alternaria tenuis</i> Nees	do. Big spots with dusky drab outlines Rotting of fruits do. Irregular spots of blackish-brown colour



TABLE I (Contd.)

No.	Host	Incitant	Symptom
20	<i>Pyrus malus</i>	.. <i>Alternaria tenuis</i> Nees <i>Phoma</i> sp. <i>Epicoccum nigrum</i> Link † <i>Nigrospora oryzae</i> (Berk. and Br.) Petch	Large circular black spots on fruits Rotting of fruits Small iron gray spots on fruits do.
21	<i>Raphanus sativus</i> (Vern. Muli)	.. <i>Fusarium</i> sp. <i>Pestalotia</i> sp.	Small dark olive gray spots on roots Large brownish drab spots on roots
22	<i>Rubus nivens</i> (Vern. Raspberry)	.. <i>Alternaria tenuis</i> Nees	Large circular blackish plumbeous spots on fruits
23	<i>Solanum melongena</i> (Vern. Baigan)	<i>Epicoccum nigrum</i> Link	Large spots with aniline black outlines on fruits
24	<i>Solanum tuberosum</i> (Vern. Alu)	.. <i>Gloeosporium</i> sp. <i>Phoma</i> sp.	Small black spots on fruits Small irregular spots with dark gray outlines
25	<i>Trichosanthes dioica</i> (Vern. Palwal)	do.	Large oval spots of dusky brown colour on fruits Rotting of fruits
26	<i>Zizyphus injuba</i> (Vern. Ber)	.. * <i>Fusarium</i> sp. † <i>Nigrospora oryzae</i> (Berk. and Br.) Petch <i>Fusarium</i> sp.  <i>Alternaria circinans</i> (Berk. and Curt.) Bolle <i>Phoma</i> sp. <i>Curvularia lunata</i> (Wakker) Boedj † <i>Cladosporium herbarum</i> (Pers.) Link	do. Cracking of fruits with blackish-green gray outlines Oval spots of fuscous black shade on fruits do. Irregular spots with bone brown outlines on fruits Irregular hair brown spots on fruits

The diseases caused by the incitants marked (\*) have recently been recorded by Srivastava *et al.*<sup>6</sup> The genus marked (†) is reported for the first time from India.

R. N. TANDON.

Botany Department,  
University of Allahabad (India),  
June 23, 1964.

ANUPAM VARMA.

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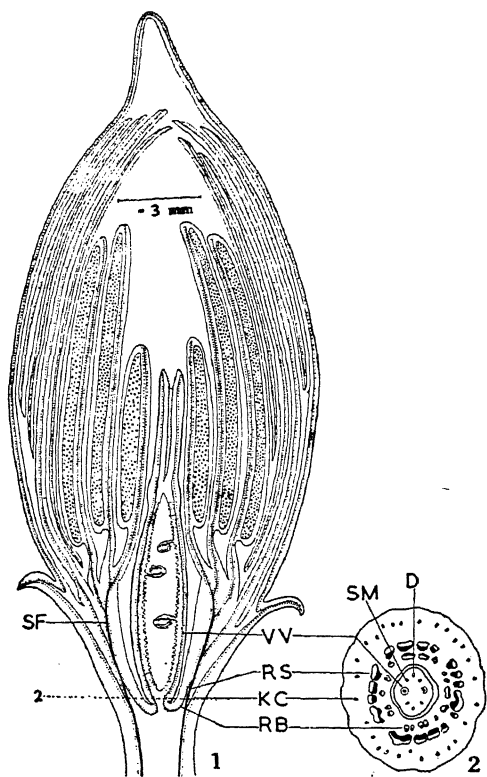
# ON THE OCCURRENCE OF RECURRENT BUNDLES IN THE FLORAL CUP OF *ESCHSCHOLTZIA* *CALIFORNICA* BENTH.

THE earlier works of Van Tieghem (1875) and Dickson (1935) on the floral anatomy of *Eschscholtzia* do not refer to the presence of recurrent bundles in its floral cup. In this note, this feature is recorded in the floral cup of *Eschscholtzia californica*.

The flowers are solitary terminal and axillary. They are perigynous and the floral cup consists of a lower vase-like portion which merges below indistinguishably into the pedicel and an upper circular platform, the calyculus or torus placed more or less at right angles to the lower vase-like portion.

The pedicel contains a ring of about 20 conjoint-collateral vascular bundles which enter into the floral cup. From this, the conjoint vascular traces of the calyculus-calyx are given off in the lower region of the floral cup. The bundles in the floral cup then ascend a little upward, give off the conjoint vascular supply of the petals and the stamens, then sharply bend inward, descend down, obviously, with inverse orientation to the base of the floral cup where they turn inward and upward, once more resuming the normal orientation and become completely utilised in the formation of the vascular supply of the gynæceum (Fig. 1). Therefore, a transection of the flower of *Eschscholtzia californica* in the lower region of the floral cup (Fig. 2) reveals the presence of 4 concentric rings of vascular bundles. These, from the periphery towards the centre, are as follows: (1) a ring of small, normally oriented bundles (KC) in the outer region of the floral cup and representing the vascular supply of

the calyculus and the calyx; (2) a ring of large, normally oriented bundles of the receptacular stele (RS) in the middle region of the floral cup; (3) a ring of comparatively smaller, inversely oriented bundles, the recurrent bundles and which are also stelar in nature and (4) a



FIGS. 1-2. Fig. 1. Median longitudinal section of a flower bud showing the coursing of the vascular bundles in its various parts. Fig. 2. Transverse section of a flower in the lower region of the floral cup (approximate level marked in Fig. 1): D, dorsal bundle of carpel; KC, conjoint vascular bundle of calyculus-calyx; RB, recurrent stelar bundle; RS, receptacular stele; SF, stamen fascicle trace; SM, secondary marginal bundle of the carpel; VV, compound marginal bundle of the carpel.

ring of normally oriented carpellary bundles (D, SM, VV) in the base of the ovary. More or less similar down-turnings in the course of the receptacular bundles inside the floral cup are known in certain species of the families Rosaceae, Calycanthaceae, Juglandaceae, Santalaceae, Cactaceae and the Punicaceae and the literature on this feature has been reviewed by Tiagi (1963).

Grateful thanks are due to Prof. S. B. Saksena for facilities.

Department of Botany, Y. D. TIAGI.  
University of Saugar, SHASHIKALA KSHETRAPAL.  
Saugar, May 20, 1964.

1. Dickson, J., *Jour. Linn. Soc. Bot.*, 1935, **50**, 175.
2. Tiagi, Y. D., *Proc. Indian Acad. Sci.*, 1963, **58**, 224.
3. Van Tieghem, M. Ph. *Mem. Acad. Inst. Imp.*, France, 1875, **21**, 1.

**GLOMERELLA CINGULATA (STONEM.)  
SPAULD. AND SCHRENK (CONIDIAL)  
ON STEMS OF EUPHORBIA LACTEA  
HAW.—A NEW RECORD FOR INDIA**

*Euphorbia lactea* is grown for its succulent and variegated stems by most cactus lovers in India. In September 1963 a severe anthracnose of this plant was observed at Kanpur, with the following symptoms and morphology of the fungus:

Anthracnose lesions on stems long, running length-wise, light brownish-white with dark-brown to somewhat violet raised margin, lesions two to several cm. long and 0.5–1.8 cm. wide, very often occupying the entire width of the triangular stem; acervuli punctiform, sub-immersed, scattered, black; conidiophores short, often not visible; conidia reniform, eguttulate, hyaline, one-celled, both ends round, ranging from  $10.8-17.2 \times 3.2-4.3 \mu$  (average  $13.4 \times 3.9 \mu$ ).

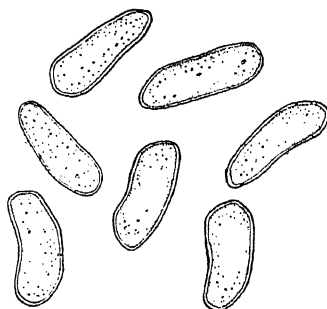


FIG. 1. Conidia of *Glomerella cingulata*.

This description agrees with *Glœosporium cerei* Pass. on *Cereus triangularis* from Italy, listed by Saccardo.<sup>2</sup> Arx<sup>1</sup> included *Glœosporium cerei* as a synonym of *Glomerella cingulata* (Stonem.) Spauld. and Schrenk (Conidial stage). The identity of the fungus was confirmed by Mr. B. C. Sutton of the Commonwealth Mycological Institute, Kew, Surrey, England (I.M.I. 104803). We are grateful for his help.

Section of the Plant

J. SWARUP.

Pathologist to Government, R. S. MATHUR.  
Uttar Pradesh,  
Kanpur, May 8, 1964.

1. Arx, J. A. von, Die Arten der Gattung, *Colletotrichum* Cda. *Phytopath. Z.*, 1957, **29** (4), 413 (10 figs).
2. Saccardo, P. A., *Syll. fung.*, 1592, **10**, 447.

## REVIEWS

**Medicinal Chemistry (Vol. 3-I)—Molecular Pharmacology—The Mode of Action of Biologically Active Compounds.** Edited by E. J. Ariens. (Academic Press, 111, Fifth Avenue, New York-3), 1964. Pp. xviii + 503. Price \$17.00.

The contributors to the volume under review, viz., E. J. Ariens, G. A. J. van Os, J. M. van Rossum and A. M. Simonis, are all members of the staff of the University of Nijmegen in the Netherlands in its Departments of Pharmacology and Biochemistry respectively. They consider the mode of action of bioactive compounds on a molecular level. The book is divided into three sections. The first section deals with the various aspects of drug distribution and metabolism; the second section deals with the drug-receptor interaction and the third section deals with the relation of stimulus to effect. Especially emphasized is the presentation of the various principles and theories applied in the study of bioactive compounds; extensive reference is made to the data in literature suitable to supply examples of the various principles.

The following significant remarks may be quoted from the foreword to the volume by Professor J. H. Gaddum of the Cambridge University: "This book is important, not because it tells us how to interpret our results, but because it makes us think about general principles and provokes argument. It is an important contribution to theoretical pharmacology and provides us all with much food for thought. It contains a most valuable review of the processes which control the uptake of drugs, their diffusion through tissues, their metabolism and excretion. It gives many examples of the successful application of mathematics, physics, chemistry, and biology to pharmacological problems".

C. V. R.

**The Development of Weak Interaction Theory (International Science Review Series, Vol. 5).** Edited by P. K. Kabir. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1964. Pp. 286. Price \$4.95.

Almost the entire subject of weak interaction theory is based on the monumental work by Fermi. Not only was it one of the first applications of quantum field theory to actual mate-

rial particles, it was also the direct inspiration for the theory of Yukawa, another of the classics of modern theoretical physics. The last five years have seen a great revival of interest in weak interaction phenomena, not only because of the sensational experimental discoveries during this period but also because of the growing realization that the interactions responsible for various decay processes offer a fascinating subject of study, both for their own sake and also as an instrument to probe the structure of strong interactions. The collection of papers reprinted in this volume is a record of progress in our theoretical understanding of this subject, which is yet far from complete. Quite naturally, the first of the reprints is the classical paper of Fermi entitled "Attempt at a Theory of  $\beta$ -rays" was published in the year 1934 in which the existence of the neutrino is assumed and the emission of electrons and neutrinos from a nucleus during  $\beta$ -disintegration is treated by a procedure similar to that followed in the radiation theory to describe the emission of a light quantum from an excited atom. Fermi derived the formulæ for the lifetime and for the shape of the emitted continuous spectrum of  $\beta$ -rays. The development of experimental techniques which occurred during the last two decades have resulted in a confirmation of Fermi's predictions regarding the shapes of  $\beta$ -spectra. The collection of reprints naturally includes numerous other papers which have influenced current progress. We may notice, in particular, the reprint of the paper by T. D. Lee and C. N. Yang on *Parity Non-conservation and a Two-Component Theory of the Neutrino* published in 1957.

C. V. R.

**Theory of Superconductivity (Volume 17 of Pure and Applied Physics).** By John M. Blatt. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 486. Price \$12.50.

The book is intended to picture the present state of knowledge of the phenomenon of superconductivity and to describe the attempts which have been made during the past decade to explain the same. The subject is treated in ten chapters, viz., (I) The Phenomenon of Superconductivity; (II) The Bose-Einstein Gas Model; (III) The Quasi-Chemical Equilibrium Theory; (IV) Self-consistent Treatment of the

Ground State; (V) The BCS and Bogoliubov Theories, at Zero Temperature; (VI) Excitation Spectrum and Thermodynamics. The Theory of Bogoliubov, Zubarev, and Tserkovnikov; (VII) Thermodynamics in the Quasi-Chemical Equilibrium Theory; (VIII) The Meissner Effect; (IX) Persistent Currents; (X) Further Problems. Two appendices deal respectively with (i) Some Concepts from Statistical Mechanics and (ii) Mathematical Formulation of the Quasi-Chemical Equilibrium Theory. The Bibliography and Author Index given at the end of the book are comprehensive and cover some fifty pages of the book.

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**Relativity, Groups and Topology** (Lectures delivered at Les Houches during the 1963 Session of the Summer School of Theoretical Physics, University of Grenoble). Edited by C. DeWitt and B. S. DeWitt. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York), 1964. Pp. xvi + 929. Price: paper, \$9.50; cloth, \$19.50.

This volume consists of ten memoirs. The longest of them is the treatise by B. S. DeWitt on 'Dynamical Theory of Groups and Fields' running to 233 pages. Next in order of length is the memoir by J. A. Wheeler entitled 'Geometroynamics and the Issue of the Final State' which covers 206 pages in the volume. J. L. Synge's 'Introduction to General Relativity' and F. Gursey's 'Introduction to Group Theory' which are the first and second articles in the book run to 87 and 74 pages respectively. These articles as well as A. Lichnerowicz's memoir on 'Propagateurs, Commutateurs et Anticommutateurs en Relativite Generale' are basically mathematical in content and will appeal specially to theorists. R. H. Dicke's article on 'Experimental Relativity' belongs to a different category. It sets out the facts of observation and the results of experimental investigation which are the basic foundations on which the theory of relativity rests. Twelve appendices to this article are useful reprints of earlier papers by Dicke and his collaborators on this and allied fields. The subject of 'Gravitational Radiation' is discussed in an article by R. K. Sachs from a theoretical standpoint, and from the experimental standpoint by J. Webber in the article entitled 'Gravitational Radiation Experiments'. Other shorter articles are by R. Penrose on 'Conformal Treatment of Infinity', and by C. W. Misner on 'Differential Geometry'.

As Sachs remarks in the opening sentence of his memoir: "General Relativity is a legitimate, though minor, part of present fundamental physics; it is interesting because it is the best available theory of gravity and also the best available theory of space-time structure; it is minor because at present it has few interrelations with the 'remainder of physics.'" It should not be assumed however that these will be permanent features. Not inconceivably, a fresh revolution of thought may bring philosophical considerations of the kind which find place in the present volume into more intimate relationship with the general trend of scientific advance. The publication of this volume is to be welcomed, if only for the reason that it brings this possibility into clearer relief.

C. V. R.

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**The Rotation of the Earth, a Geophysical Discussion.** By W. H. Munk and G. J. F. Macdonald. (Cambridge University Press, London, N.W. 1), 1960. Pp. xix + 323. Price 70 sh.

This publication will prove useful to geophysicists and others engaged in a close study of those branches of Earth sciences which have a bearing to the rotation of the Earth. The book gives an account of certain irregularities in the rotation of the Earth which are not ordinarily included in gravitational theory. These are largely caused by events on, and in, the Earth. The contributions of Sir Harold Jeffreys to this field are well known and the mathematical discussions presented in this monograph are largely based on them.

These rotational irregularities manifest themselves as changes in the observed latitude and the length of day. Hence the international latitude service and the astronomers' length of day measurements form the primary sources of information in these studies. Records of ancient eclipses also furnish useful data.

The following chapter headings will give an idea of the treatment of the subject by the authors: Precession, nutation and wobble; Dynamics; Deformation; Love numbers and associated coefficients; Solutions to the approximate Liouville equation; Observations of latitude; Observations of the length of day; Seasonal and other short-period variations; Chandler wobble; Historical variations; Geological variations.

A. S. G.

**Enzymes in Blood Plasma.** By Benno Hess. (Translated from German by S. Henley). (Academic Press, New York-3), 1963. Pp. xii + 167. Price \$ 8.00.

*Enzymes in Blood Plasma* is an English translation by K. S. Henley of the book written by Benno Hess in German. It is a concise treatise of biochemical and clinical aspects of plasma enzymes. Of special interest, are the kinetics, quantitative aspects of separation and identification of plasma enzymes with respect to the various tissue disorders. Further, the origin and release of plasma enzymes are dealt with in great detail.

In the chapter on "Pathology and Clinic", various aspects on prognosis and diagnosis of diseases of the heart, liver, pancreas, muscle, blood, kidney, etc., by studying the plasma enzymes have been discussed. The approach for the differential diagnosis of a particular disease has been described in sufficient detail. For example, the diagnosis of a specific heart disorder, by studying plasma enzymes such as creatine kinase and the ratio of GPT to GOT has been well brought out. Similarly the importance of electrophoresis in the separation and identification of organ specific enzymes in the plasma has been adequately stressed.

The clinician and the clinical biochemist who use plasma enzymes as a tool for an accurate diagnosis of various tissue disorders will find this volume a valuable addition to his library.

P. S. SARMA.

**Chemical Plant Taxonomy.** Edited by T. Swain. (Academic Press, London and New York), 1963. Pp. ix + 543. Price 110 sh.

This book is the first attempt to bring together plant taxonomy and plant chemistry. To the botanist it is a good source of some basic information regarding the distribution of particular chemical constituents in certain taxa. The book is divided into 16 chapters of which the first two have been devoted to a general consideration of classical taxonomy and species concepts. The third chapter deals with the history of chemical taxonomy. The remarks by Professor H. Erdtman in the next chapter in regard to the authenticity of plant material and their nomenclature is particularly noteworthy for those interested in chemotaxonomic work. The rest of the book gives an account of the distribution of different chemical constituents in closely related genera and species of plants and their value in plant classification. Emphasis is placed on the so-called secondary plant products

in distinguishing one group of plants from another by virtue of their oft-noted restricted distribution in certain taxa. It is, however, clear that the biosynthesis of these substances also involve enzyme systems, a study of which should indeed add much to phylogenetic information. In other words, the importance of primary plant products like proteins, in chemotaxonomy, appears equally significant. However, the book should prove particularly useful to those interested in chemotaxonomy.

T. S. SADASHIVA.

**Advances in Child Development and Behaviour** (Vol. 1). By L. P. Lipsitt and C. C. Spiker. (Academic Press, New York), 1963. Pp. xiii + 387. Price \$12.00.

The book *Advances in Child Development and Behaviour* (Vol. 1) does not deal with any particular topic or theme but presents review articles from various investigators conducting programmatic research on developments in child psychology and problems of current interest.

Eleven specialists working in the Departments of Psychology and Institute of Child Behaviour and Development from seven American Universities have contributed to this volume.

Among the topics which appear in this book are: The responses of infants and children to complex and novel stimulation, word associations and children's verbal behaviour. Methodological and functional analysis of child development, Experiments in the discrimination learning of retardates, and theoretical aspects of experiments which define new paths of experimental work. This book also describes new apparatus and techniques and provides other valuable information to investigators in the field, especially to research workers, psychologists and doctors. The book is highly technical and the presentation is by no means popular as to interest the common reader or keen parents.

K. S. B.

**Lightweight Concrete.** By A. Short and W. Kinniburgh. (Asia Publishing House, Bombay), 1963. Pp. 368. Price Rs. 35-00.

This is a well-written book on the subject of lightweight concrete which, of late, has become an important class of materials in building construction.

The book consists of 24 chapters and 2 appendices. A selected bibliography and conversion tables given at the end add to the usefulness of the book. After a general introductory

treatment in the first chapter, the chemical aspects of lightweight concrete are discussed in the second chapter. Four important classes of lightweight concrete are treated: (1) No-fines concrete, (2) Lightweight aggregate concrete, (3) Structural lightweight aggregate concrete and (4) Aerated concrete. Chapters 3 to 6 deal with mix design, curing, drying shrinkage and cracking and functional properties of lightweight concrete. Then the individual classes of concrete find detailed treatment. Chapter 7 deals with no-fines concrete. In chapters 8 and 9, lightweight aggregate and load-bearing lightweight aggregate concrete and reinforced lightweight aggregate constructions are fully described. Chapters 10 to 15 deal in detail with all aspects of structural lightweight aggregate concrete and this material is useful for structural engineers. Aerated concrete is discussed in five chapters. A small chapter is devoted to insulation-grade aggregate concrete. The last two chapters contain material on precast lightweight concrete products and lightweight concrete walls.

One useful aspect of the book is that the matter covered is up-to-date and has been taken from the results of recent research studies in U.S.A., U.K. and the Continent. Each chapter contains a list of important references.

This is a very useful book both for the student as a text and the engineer as an informative one.

K. T. S. IYENGAR.

**Quantum Field Theory and the Many-Body Problem.** By T. D. Schultz. (Gordon and Breach, Science Publishers, New York and London), 1964. Pp. viii + 150. Price: Cloth, \$ 6.95. Paper, \$ 3.95.

The book under review provides an introduction to the recent developments in the theory of the many-body problem, which depend heavily on the formalism of the quantum field theory, especially the Green's function method. The first two chapters supply the requisite background needed to understand the perturbation techniques and cover the second quantization formalism, the Heisenberg and the Schrödinger pictures. The third chapter gives a detailed exposition of the many-fermion system at absolute zero, starting from the definition of the Green's function and ending with the most recent developments in the diagrammatic perturbation techniques. This chapter will prove to be very valuable to a research worker in many-body theory as it contains a lucid and systematic account of the single and many-particle Green's function, the series expansion

for the Green's function, the diagrammatic analysis of the iteration solution and the ground state energy of a free electron gas. The interaction between the electronic motion and the lattice oscillations, which forms the basis of the theory of superconductivity, is dealt with in chapter four. The last chapter is a generalisation of the Green's function technique to cover fermion systems at finite temperatures, and contains a survey of the work by Matsubara, Martin and Schwinger and by others on the temperature-dependent Green's functions.

Several books have appeared in recent years on the many-body problem, but most of them are collections of reprints of the important developments in the field, and there is still a definite need for a text-book which will "introduce" this fascinating branch of theoretical physics to either a non-specialist or a beginner. The present volume serves this purpose admirably and for this reason, it is recommended warmly to all physicists interested in mastering the Green's function technique.

K. S. VISWANATHAN.

#### Books Received

From: (Academic Press, New York-10003):

*The Liver—Morphology, Biochemistry, Physiology* (Vol. II). Edited by Ch. Rouiller, 1964. Pp. xiv + 674. Price \$ 24.00.

*Radiation and Immune Mechanisms.* By W. H. Taliaferro, L. C. Taliaferro and B. N. Jaroslow, 1964. Pp. xvi + 152. Price: Cloth, \$ 5.95; Paper, \$ 3.45.

*Proceedings of the International School of Physics "Enrico Fermi" Course 26: Elementary Particles*, 1963. Pp. xi + 294. Price \$ 10 00.

*Biochemical Disorders in Human Diseases.* Edited by R. H. S. Thompson and E. J. King, 1964. Pp. xx + 1066. Price \$ 22.00.

*Foundations of General Topology.* By W. J. Pervin, 1964. Pp. xi + 209. Price \$ 7.95.

*Generalized Functions* (Vol. 1)—*Properties and Operations.* By I. M. Gel'fand and G. E. Shilov, 1964. Pp. xviii + 423. Price \$ 12.00.

*Electronic Methods* (Vol. 2) Edited by E. Bleuler and R. O. Haxby, 1964. Pp. xii + 839. Price \$ 24.00.

*Infra-Red Spectroscopy of High Polymers.* By R. Zbinden, 1964. Pp. xii + 264. Price \$ 9.50.

*Elements of Numerical Analysis.* By J. Singer, 1964. Pp. x + 395. Price \$ 8.75.

*The Lunar Surface Layer Materials and Characteristics.* By J. W. Salisbury and P. E. Glasser, 1964. Pp. xxvi + 532. Price \$ 12.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the Ph.D. Degree in Nuclear Physics to Sri. V. V. Gangadhara Sastry for his thesis entitled "Studies on Radioactive Decay using Sum and Sumpeak Coincidence Scintillation Spectrometers"; D.Sc. Degree in Chemistry to Sri. C. Someswara Rao for his thesis entitled "Synthetic Investigations in Polycyclic Systems"; Ph.D. Degree in Chemistry to Sri. D. Nageswara Rao for his thesis entitled "Chemistry of Euphorbia Species".

M.S. University of Baroda has awarded the Ph.D. Degree in Chemistry to Sri. J. M. Trivedi for his thesis entitled "Studies in Compounds Containing the Reactive Methyline Group and Organo-Arsenicals".

### Effect of Nitrogen and Plant Population on Hybrid Maize Yield

Messrs. K. K. Mandloi, S. K. Dubey and S. K. Nigam of Co-ordinated Maize Breeding Scheme, Chhindwara (M.P.), write:

An experiment was conducted at the Maize Research Station, Chhindwara (M.P.), from 1961-62 to 1963-64 with a view to determine the effect of nitrogen and plant population on yield of maize. In this experiment plant populations 35880, 43056 and 53820 plants/hect. and levels of nitrogen 67, 134 and 202 kg./hect. were tried with Deccan Hybrid and local variety.

On the basis of three years data it was found that maximum yields are associated with highest plant population of 53820 plants/hect. in case of hybrid as well as the local. It is also interesting to report that application of 134 kg./hect. of nitrogen to hybrid maize gives maximum economic return of Rs. 1,259/hect. whereas the local variety gives maximum economic return of Rs. 846/hect. with only 67 kg./hect. of nitrogen. In the case of local variety higher doses of N from 67 to 202 kg./hect. tend to reduce economic returns.

### Nomenclature of Multiple Enzyme Forms

Dr. Edwin C. Webb, a member of the Sub-Committee on Isoenzymes, set up by the Enzyme Commission, writes in *Nature* (August 22, 1964) on certain decisions reached by it and approved by the Standing Committee on Enzymes. We give below the relevant recommendations:

"When multiple forms of an enzyme are identified by electrophoretic separation, they should be given consecutive numbers, the form having the highest mobility towards the anode being numbered one."

"Multiple enzyme forms in a single species should be known as *isoenzyme*, although since either form (*iso-enzyme* or *isozyme*) is readily intelligible this recommendation is not to be interpreted as excluding the use of 'isozyme' if any individual author prefers it."—(*Nature*, 1964, 203, 821.)

### Anomalous Bottom Water in the Red Sea

Water below 1,000 m. in the Red Sea usually has a potential temperature between 21.5 and 21.6° C. and a salinity close to 40.6 parts per thousand. But in a small basin around 21° 15' N., 38° 05' E., three research vessels, during the IGY, have reported anomalously warm and salty water in the lowest 50 m. In this small basin, the depth of which is about 2,000 m., the potential temperature reached 25° C. and the salinity 44‰.

A few miles to the south there is a large basin, the depth of which approaches 2,400 m. According to a hydrographic survey of this basin made from R.R.S. *Discovery* on March 1, 1964, the water below 1,500 m. contained the anomalous water much diluted with typical Red Sea deep water. The anomalous water is clearly not widely distributed, and its origin is not clear. A plausible explanation is that it forms in a very shallow land-locked basin and is transferred across the sill by wind action, then to descend as a density current on the bottom.—(*Nature*, 1964, 203, 591.)

### Production of Coherent Beat-Frequency Light in Raman Maser Study

Ruby maser sources have been employed to study non-linear optical phenomena, such as frequency doubling, mixing and rectification of light waves in dielectrics. The theoretical explanation of the phenomena is essentially based on the induced polarization, involving quadratic terms, in the dielectric under the influence of the intense electric field of the irradiation. Thus, upon the projection of intense light at frequencies  $\omega_1$  and  $\omega_2$  through a piezoelectric crystal, it should be possible to simultaneously produce  $2\omega_1$  second harmonic light, and  $(2\omega_1 - \omega_2)$

beat-frequency light. Such an occurrence of a coherent beat-frequency signal about  $10^8$  times greater in power than the incoherent output has been reported by using a ruby-benzene Raman maser.

The Q-switched ruby-benzene Raman maser used in the experiment produced pulses about 1.0 and 0.2 MW peak of ruby laser line  $\omega$  light (6940 Å) and stimulated Raman scattering  $\omega - \Delta\omega$  (7454 Å) with  $\Delta\omega$  corresponding to 992  $\text{cm}^{-1}$  benzene shift. When the beam was focused into a carefully oriented crystal of ammonium dihydrogen phosphate (ADP), and the emergent light spectrometrically examined, light of wavelength  $\sim 6496$  Å corresponding to the beat-frequency light  $[2\omega - (\omega - \Delta\omega)]$  was observed. At the ADP orientation for optimum conversion efficiency the power of this  $\omega + \Delta\omega$  light was estimated at  $10^{-2}$  W, against the incoherent output of  $10^{-10}$  W.—(*J. App. Phys.*, 1964, 35, 2,239.)

#### Radiation Scattered from the Plasma Produced by a Focused Laser Beam

When the intense laser beam from a ruby laser is focused by a short lens, at the focal region gas breakdown takes place with a spark and production of ions and free electrons. In a communication to *Physical Review Letters*, S. A. Ramsden and W. E. R. Davies of the National Research Council, Ottawa, report observation of scattering of the laser beam itself by the plasma so formed at the focused spot.

The beam from a Q-spoiled ruby laser was focused by a lens of 8 mm. focal length. At output powers of 5 MW and above, a spark was produced at the focal point in air, and radiation from the spark was observed in a direction at right angles to the beam by means of a spectrograph equipped for both photographic and photoelectric recording.

The scattered radiation appeared as a sharp line close to the laser wavelength, but shifted from it (almost always towards the shorter wavelengths) by up to 3 Å. The observations are consistent with scattering by the free electrons in the focal plasma, under conditions such that the spectral distribution of the scattered radiation is governed by co-operative interactions between the ions and electrons. The shift in the wavelength observed is interpreted as a Doppler shift due to motion of the plasma during the initial phase of the spark. Such a

motion is clearly seen on a streak photograph of the spark taken with an image-converter camera. (An image-converter camera provides time resolved spatial and intensity data for any luminous transient event.) The velocity of the plasma front computed as  $\sim 10^7$  cm./sec. is in good agreement with the observed shift of 3 Å towards the blue.—(*Phys. Rev. Letters*, August 17, 1964.)

#### New Type of Stellar Interferometer for Measurement of Angular Diameter of Stars

A new type of stellar interferometer, based on the original design of Hanbury Brown and Twiss, recently completed at Narrabri Observatory, near Sydney, Australia, can measure angular diameter of stars to an accuracy of 0.002 sec. of an arc, and gives promise of measurements to an accuracy of 0.001 sec. with further refinements. With the purely optical stellar interferometer at Mount Wilson Observatory, angular diameters of bigger stars could be measured to a considerable degree of accuracy. But the same technique could not be applied to smaller stars because of lack of precision.

In 1956, Prof. R. Hanbury Brown and Dr. R. Q. Twiss of Sydney University, designed a new type of interferometer in which the light signals received from a star by two mirrors (instead of interfering optically as is required in precision optical interferometers) were picked up by photomultipliers and correlated electronically. The difference in phase between certain signal characteristics received by the two mirrors depends on their distance apart and the angular size of the star. In the case of smaller stars the spacing of the mirrors has to be great, and even with the originally constructed apparatus the angular diameter of Sirius, one of the smallest stars, was measured as 0.0071 sec. of arc.

The present improved design at Narrabri consists of two 22 ft. composite mirrors each made up of 250 separate hexagonal mirrors with spherical surface, run on trucks round a circular railway track 618 ft. in diameter. The mirrors are made to focus a particular star by an automatic control system and the electrical signals are carried by cables to an electronic correlator in the centre of the truck.

With the new instrument it will also be possible to study the variation of brightness across the star's disc.—(*New Scientist*, 1964, 21, 730.)



## THE NEW PHYSIOLOGY OF VISION

### Chapter IV. Corpuscles of Light and the Perception of Form

SIR C. V. RAMAN

THE observations described in the preceding chapter provide us with a fresh insight into the nature of vision. Our visual sensations are the resultant of an immense number of discrete processes, each of which is a chance event, viz., an individual corpuscle of light being taken up by a receptor unit in the retina and transformed into an impulse which reaches the centres of perception. The superposition of these unit processes in large numbers does not necessarily result in every trace of their discreteness being effaced. The fluctuations of luminosity seen by an observer on the surface of a uniformly illuminated screen viewed by him are evidence to the contrary. As is to be expected, the character of the observed fluctuations is found to depend on the strength of the illumination of the screen, the distance from which it is viewed and on the spectral character of the illumination.

In the present chapter, we shall concern ourselves with the part played by similar considerations in the normal functioning of our visual organs. The binocularity of vision not only enables us to perceive the form of the objects around us but also to locate their relative positions in three-dimensional space. We shall not here enter into this more recondite subject and will confine ourselves to the simpler aspects of vision, viz., the perception and recognition of the form and features of individual objects in two-dimensional space. Even here, we shall, in the first instance, begin by considering cases of a relatively simple type.

*Observations with Test-Charts.*—Perhaps the most frequent use of vision in daily life is the reading of printed material of various sorts. Constant familiarity enables us instantly to recognise the letters of the alphabet when presented to us. It is, therefore, not surprising that in ophthalmic practice, the material commonly made use of for examining vision and prescribing the corrective glasses needed in cases of defective eye-sight consists of sets of letters printed in black on white card, thus providing the maximum of contrast between the object and the background against which it is viewed. In the well-known Snellen test-charts, there are in all eleven rows of letters, the first consisting of a single letter of large size, and the others following it containing letters of smaller sizes and in greater numbers. The standard

charts are designed to be set at a distance of six metres between the chart and the observer, this being regarded as representative of distant vision. The sizes of the letters on the chart have been so adjusted that an observer with average normal vision can recognise and read the letters in the eighth line, but cannot proceed further. If he can read the lines beyond the eighth, his vision is better than the average normal. Ability to read the eleventh and last line on the chart indicates a visual acuity twice the normal average, but such cases are relatively rare.

If an ophthalmic test-chart is to serve the purposes for which it is intended, it should be adequately illuminated, either artificially or by ordinary daylight. For an investigation of the relationship between visual acuity and the level of illumination, it is necessary to have an arrangement by which the strength of illumination can be controlled and varied over a wide range. For this purpose, the author makes his observations in a darkened room into which skylight is admitted through a circular window set fairly high up and having a diameter of 25 centimetres. This window is covered by a large and specially made iris-diaphragm, the diameter of the opening of which can be varied from the full value of 25 centimetres down to 5 millimetres as desired, thereby providing for a reduction of illumination by a ratio of 2500:1. The test-chart is set facing the window and at such a distance from the observer that the eighth line of letters can be comfortably read. As the illumination is diminished progressively, the observer maintaining his distance from the chart, successive rows of letters, one after another, become indistinct, then unreadable and finally unobservable. At the lowest level of illumination, even the first large letter on the chart can scarcely be seen. But if at any level of illumination, the observer, instead of remaining at the same position, approaches sufficiently near to the test-chart, the letters become clear again, in other words, the effect of diminished illumination can be set off by diminishing the distance of observation.

The progressive fall in the acuity of vision with diminishing strength of illumination thus manifest is readily understood when it is realised that for perceiving an object clearly, it is necessary that the corpuscles of light reaching

the retinae of the observer from all parts of the object are sufficiently numerous to give rise to an integrated perception of its entire form. The feebler the illumination, the less likely it is that this requirement is satisfied. We would then be unable to perceive the whole object, but only see parts of it which vary from instant to instant. In other words, a fluctuating and broken-up picture of the object is presented to us instead of a clear and complete image of it. With any further reduction in the illumination, the visual image would cease to be recognisable and would ultimately tend to disappear.

The foregoing is a statement of what is actually seen of the individual letters on the test-chart and correctly describes their appearance as the iris-diaphragm of the window is progressively closed down. Indeed, at the lowest levels of illumination, the phenomenon of an entire letter disappearing from sight and reappearing immediately afterwards is often noticeable. We may here raise and answer the question why when the observer comes sufficiently close to the chart, letters which were previously indistinct and even invisible come into view again. The answer is that the image of a letter on the retina is then much enlarged and at the same time, the number of light-corpuscles reaching the image is increased in the same proportion. In consequence, the fluctuations of the image would, relatively to its perceived size, be on a much smaller scale, and the resulting fragmentation of the image would not therefore prevent its form as a whole being perceived and recognised.

The foregoing description and discussion refer to the case of a Snellen chart of the standard size held at a considerable distance from the observer. Essentially similar observations can also be made with charts printed on a reduced scale so that the entire chart can be held at arm's length. The disappearance of the lines on the chart one after another as the illumination is reduced is also noticed in this case. But it is not quite so easy using the smaller charts to observe and follow the fragmentation of the images as the fluctuations which cause such fragmentation are on a much smaller scale.

*Observations with Monochromatic Light.*—As in the studies described in the preceding chapter, the use of monochromatic illumination instead of ordinary daylight is strongly to be recommended for the study of visual acuity. Using such light, e.g., the light of a sodium-vapour lamp, it is easy to recognise the relationship between the effects observed on a uniformly

illuminated screen and those exhibited by a test-chart carrying printed letters. Putting two side by side so that they are equally illuminated, it becomes evident that the fluctuations observed in both cases have a common cause and are closely related to each other. The moving areas of light and shade are of approximately the same size in both cases in any particular circumstances of observation. In an earlier chapter, it was remarked that using a 4358 radiations of the mercury arc, the fluctuations visible on a screen uniformly illuminated with such light are extremely conspicuous. It is to be expected, that in these circumstances the visibility of letters on a test-chart would be very low with such illumination. This was indeed made evident by actual observation. The contrast with the much higher visual acuity observed using the light of the sodium lamp is very striking.

*Binocular Observations of Visual Acuity.*—A noteworthy observation was recorded in the preceding chapter that the fluctuations of luminosity on a uniformly illuminated screen are more conspicuous when viewed with one eye of the observer open (the other closed) or *vice-versa*. It was remarked that this observation indicates the fluctuations of luminosity as seen by the retinae of the eyes to be independent and the effect of binocular superposition is thereby to diminish visibility. Having regard to these remarks, it is significant that when a test-chart is viewed under reduced illumination, the visibility of letters is notably improved by using both eyes. *Per contra*, it is visibly diminished by using one eye or the other. This is what we expect if the diminished visibility of the test-chart is the result of fluctuations in the perceived retinal images. If both eyes are used, the binocular superposition would tend to suppress the fluctuations in the perceived images and thereby to improve their visibility.

*Scintillating Charts.*—An effective demonstration of the role played by fluctuations of luminosity in visual acuity and the perception of form is forthcoming when the Snellen chart containing rows of letters of diminishing size are replaced by charts in which the letters under view are all similar to each other and are arranged in regular geometric order. One of this kind can readily be prepared on a white bristol board using Indian ink to form up a succession of strips all of equal width arranged both horizontally and vertically set at equal intervals. We thus obtain a chart consisting of white squares on a black

ground, equidistant and all of the same size and arranged in rows and columns forming a regular pattern. It is useful to prepare a number of such charts in which the squares are of different sizes, e.g., 5 mm.  $\times$  5 mm., 1 cm.  $\times$  1 cm. and 2 cm.  $\times$  2 cm.

All the three charts may conveniently be set side by side and illuminated in the same fashion, so that they may be readily compared with each other. The monochromatic light provided by a sodium-vapour lamp is well suited for the purpose and by the use of an iris-diaphragm the illumination of the charts may be varied over a wide range of values. When the illumination is sufficient and the observer is not at a great distance from the charts, the white squares on all three charts are seen with clear and sharply-defined boundaries. But when the illumination is progressively reduced, this is no longer the case. The chart with the smallest

squares first shows the alterations in appearance and is followed by the two others in the order of the sizes of the squares. The effects of increasing the distance of the observer also follow the same order. The most interesting cases are those in which the squares continue to be visible but with much less than the maximum definition. It is then noticed that the squares fluctuate in brightness, the difference between each square and its nearest neighbours being readily observable. In the case of the chart with the 5 mm. squares, the changes in brightness give rise to an effect resembling scintillations. The charts with the larger squares also exhibit curious and continuously changing deformations in the form of the white areas, while inside those areas irregular patterns of light and shade are visible; these patterns vary from square to square and also change continuously.

## A WEIGHTING FUNCTION TO RESOLVE THE TWO-FOLD AMBIGUITY IN THE PHASE DETERMINED BY THE ANOMALOUS DISPERSION METHOD IN CRYSTAL STRUCTURE ANALYSIS

S. PARTHASARATHY, G. N. RAMACHANDRAN AND R. SRINIVASAN

*Department of Physics, University of Madras, Madras-25, India*

### INTRODUCTION

THE importance of the anomalous dispersion method in solving the structure of non-centrosymmetric crystals with suitable heavy atoms has been well recognized in recent years. With a proper choice of the wavelength and heavy atom it is possible to measure the Bijvoet difference of a large number of reflections. It is then possible to determine the phase of a reflection but for a two-fold ambiguity.<sup>1,2</sup> Various methods proposed<sup>1,3</sup> to resolve this ambiguity are (i) to use a pair of isomorphous crystals in which the anomalous scatterers form the replaceable group of atoms; (ii) to use both the phases and compute a double-phased synthesis. This is the same as the  $\beta$ -anomalous synthesis proposed by Ramachandran and Raman<sup>4</sup>; (iii) to use the phase closer to the phase of the heavy-atom contribution to the structure factor. This method has been successfully used by Raman,<sup>5</sup> Dale *et al.*<sup>6</sup> and Chopra *et al.*<sup>7</sup>

However, since the presence of anomalous scatterers (i.e., heavy atoms) in a crystal biases the phase angle distribution to be closer to the heavy atom phase, the double-phased synthesis in which the two ambiguities are given equal weights is not consistent with the statistical

theory. So also, the method (iii) in which one ambiguity is given unit weight and the other zero weight is also not fully compatible with statistical considerations. Thus, we are naturally led to work out a weighting function in which the two ambiguities are given weights depending on their probabilities of occurrences. Such a weighting function is derived below.

### DERIVATION OF THE WEIGHTING FUNCTION

We consider a non-centrosymmetric crystal containing  $P$  anomalous scatterers of the same type and  $Q$  normal scatterers (i.e., light atoms) in the unit cell. Let  $N (= P + Q)$  be the total number of atoms in the unit cell. The two ambiguous phases obtained by the anomalous dispersion method are shown in Fig. 1, in which

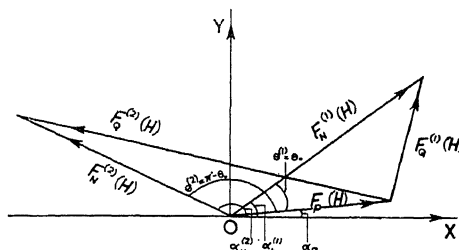


FIG. 1. Argand diagram showing the two-fold ambiguity in the phase determined by the anomalous dispersion method.

$\theta_0$  is the acute one of the two possible values for  $\alpha_N - \alpha_P$ , which are obtained by solving the triangle for the Bijvoet difference. The other value will obviously be  $\pi - \theta_0$ . The structure factor equation of a reflection  $H$ , corresponding to the two ambiguous values can be written as

$$F_N^{(i)}(H) = F_P(H) + F_Q^{(i)}(H) \quad (1)$$

where  $i (= 1, 2)$  refers to the ambiguities  $\theta_0$  and  $\pi - \theta_0$  for  $\alpha_N - \alpha_P$ . Since the probabilities for the events  $F_Q^{(i)}$  to occur are known to be<sup>8</sup>

$$P[F_Q^{(i)}] = \left( \frac{1}{\pi \sigma_Q^2} \right) \exp \left[ -\frac{|F_Q^{(i)}|^2}{\sigma_Q^2} \right] \quad (2)$$

where

$$\sigma_Q^2 = \sum_{j=1}^Q f_Q^2,$$

it is clear from Equations (1) and (2) that the probabilities of occurrence of the events  $F_N^{(i)}$  for a given  $F_P$ , are given by

$$P[F_N^{(i)}; F_P] = \left( \frac{1}{\pi \sigma_Q^2} \right) \exp \left[ -\frac{|F_N^{(i)} - F_P|^2}{\sigma_Q^2} \right]. \quad (3)$$

Since  $|F_N^{(1)}| = |F_N^{(2)}| = |F_N|$ , say, we can write Equation (3) as

$$P[F_N^{(i)}; F_P] = K \exp[-X \cos \theta^{(i)}] \quad (4)$$

where we have used the simplifying notations

$$K = \left( \frac{1}{\pi \sigma_Q^2} \right) \exp \left[ -\frac{(|F_N|^2 + |F_P|^2)}{\sigma_Q^2} \right]$$

$$X = \frac{2|F_N||F_P|}{\sigma_Q^2} \quad \text{and} \quad \theta^{(i)} = \alpha_N^{(i)} - \alpha_P. \quad (5)$$

It is clearly seen that

$$\theta^{(1)} = \theta_0,$$

$$F_N^{(1)} = |F_N| \exp i\alpha_N^{(1)}$$

$$= |F_N| \exp i(\alpha_P + \theta_0) \quad (6a)$$

and

$$\theta^{(2)} = \pi - \theta_0,$$

$$F_N^{(2)} = |F_N| \exp i\alpha_N^{(2)}$$

$$= |F_N| \exp i(\alpha_P + \pi - \theta_0). \quad (6b)$$

Now, each  $F_N^{(i)}$  may be weighted with its probability of occurrence, taking the total weight assigned for all events to be unity. The weighted structure factor  $F_N^W$  will then be given by

$$F_N^W = \left\{ \frac{\sum_{i=1}^2 F_N^{(i)} P[F_N^{(i)}; F_P]}{\sum_{i=1}^2 P[F_N^{(i)}; F_P]} \right\}. \quad (7)$$

Using Equations (4) and (6) in Equation (7) and simplifying the resulting expression, we get

$$F_N^W = [|F_N| \exp i\alpha_P] \times [\cos \theta_0 \tanh(X \cos \theta_0) + i \sin \theta_0]. \quad (8)$$

Since  $|F_N| \exp i\alpha_P$  is the coefficient used in the conventional heavy-atom method, we may write

$$F_N^W = W |F_N| \exp i\alpha_P \quad (9)$$

where the weighting function  $W$  is given by

$$W = \cos \theta_0 \tanh(X \cos \theta_0) + i \sin \theta_0$$

$$= |W| \exp i\alpha_W \quad (10)$$

where

$$|W| = [(\cos \theta_0 \tanh(X \cos \theta_0))^2 + \sin^2 \theta_0]^{\frac{1}{2}}$$

and

$$\alpha_W = \tan^{-1} \left\{ \frac{\tan \theta_0}{\tanh(X \cos \theta_0)} \right\}. \quad (11)$$

This weighting function can be readily computed from the known positions of the anomalous scatterers, the known contents of the unit cell and the measured Bijvoet difference. Since the weighting function derived here is a complex quantity, it leads to a correction in the amplitude as well as a change in the phase of the structure amplitude.

It is obvious that the weighted structure amplitude given by Equation (9) is statistically the best that can be used in a Fourier, making use of anomalous dispersion data. It is also clearly superior to the usual weighted synthesis<sup>9</sup> using only the heavy-atom phase. Investigations regarding the power of this weighting function and details regarding tests of its usefulness will appear elsewhere.

#### ACKNOWLEDGMENT

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*Note added in proof.*—Since this note was sent to press, a short communication by G. A. Sim (*Acta Cryst.*, 1964, 17, 1072) has come to the attention of the authors in which similar results have been derived.

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# MODE OF HARDENING OF THE CUTICLE OF *MACHILIS VARIABILIS* (APTERYGOTA: THYSANURA)

G. KRISHNAN AND G. SUNDARA RAJULU

Department of Zoology, University of Madras, Madras

IT is well known that the cuticle of insects is hardened by tanning of its protein involving cross-links between "polypeptide chains introduced by a reaction with an accessory molecule" usually a phenol.<sup>1,2</sup> The occurrence of tanning is indicated by the presence in the formative stages of the cuticle of phenols, polyphenol oxidase and a protein rich in aromatic amino-acid residues. Other evidences of tanning include dissolution of fully tanned cuticles by treatment with sodium hypochlorite.<sup>3</sup> The absence of reaction with keratinolytic agents which break up disulphide bonds provide additional evidence. In the light of these observations it was of interest to note a complete absence of tanning in the cuticle of *Machilis variabilis*. The unusualness of this feature, which marks a departure from what has hitherto been thought a characteristic of insect cuticles, warrants a

hyaline and non-reactive to stains. Lower<sup>4</sup> considered that the fuchsinophil part of the pro-cuticle is the mesocuticle suggesting thereby its similarity to that of insects. This author endeavoured to relate the structure and chemical composition of the cuticle of the thysanuran to that of pterygote insects.

In the present study of the cuticle of *Machilis variabilis* it is found that both the hyaline epicuticle and the so-called mesocuticle do not react to any of the tests indicative of tanning, including treatment with detanning agents like sodium hydrochlorite and diaphenol.<sup>3,7</sup> However, after treatment with alkaline sodium sulphide the hyaline epicuticle is rendered reactive to stains like Mallory, turning fuchsinophil while at the same time the mesocuticle loses its fuchsinophily and takes up a blue colour (Table I). Alkaline sodium sulphide

TABLE I  
Histochemical reactions shown by the layers of the cuticle of *Machilis variabilis*

No.	Tests	Reference	Outer epicuticle	Inner epicuticle	Mesocuticle	Endocuticle
1	Mallory's triple stain	.. Mallory, 1938	Blue	Hyaline	Red	Blue
2	do. after sodium hypochlorite	Brown, 1950	do.	do.	do.	do.
3	do. after diaphenol	.. Kennaugh, 1957	do.	do.	do.	do.
4	do. after alkaline sodium sulphide	Brown, 1950	do.	Red	Blue	do.
5	Nitroprusside test	.. Pearse, 1961	—	++	+	—
6	Ferric-Ferricyanide test	.. Pearse, 1961	—	++	+	—
7	Blue-tetrazolium test	.. Barnett and Seligman, 1954	—	+++	++	+
8	Thioglycollate	.. Brown, 1950	—	Swells	Swells	—
Key: + Positive; ++ Intensely positive; — Negative						

fuller examination of the nature of the cuticle-protein and the mode of its stabilization.

An account of the structure of the cuticle of the thysanuran *Ctenolepisma longicaudatus* has been given by Lower.<sup>4</sup> As reported therein, *Machilis variabilis* shows two well-marked divisions, an outer thin layer about 3  $\mu$  thick corresponding to the epicuticle of the larva of *Sarcophaga*<sup>5</sup> and underlying it a wider layer distinguishable as the procuticle in which the outer regions are differentiated by its fuchsinophil reaction from the inner part which takes up a blue colour in Mallory's stain.<sup>6</sup> The epicuticle likewise may be differentiated into a very thin bounding membrane which stains blue in Mallory while the rest of the epicuticle is

breaks up disulphide linkages as has been noted in —S—S— bonded protein of the epicuticle of the scorpion *Palamneus swammerdami*.<sup>8,9</sup> The suggestive evidence provided by the reaction to sodium sulphide is further supported by other tests (Table I). The results obtained with Nitroprusside test after a pretreatment with thioglycollate indicate the presence of SH groups in the mesocuticle. By the Ferric-Ferricyanide test which coloured both the epicuticle and mesocuticle, and the Blue-tetrazolium test which was positive in both the epicuticle and the entire procuticle, the occurrence of organic sulphur may be inferred.<sup>10,11</sup> The cuticle was homogenized and treated with sodium carbonate and potassium nitrate and after dissolving in warm

water was filtered. The filtrate was acidified with hydrochloric acid and heated to boiling-point. On addition of barium chloride a white precipitate was formed showing the presence of organic sulphur.<sup>12</sup> In thioglycollate treatment the epicuticle showed a marked swelling. These results accord with the inference that the cuticle-protein may be stabilized by sulphur bridges as in keratin. It seems clear that in chemical composition and mode of stabilization, the cuticle-protein of *Machilis variabilis* is not comparable to arthropodin of pterygote insects.<sup>13,14</sup> Unlike the latter the protein component of this type is negative to Millon, xanthoproteic and Hg/nitrite tests. From the negative ferric chloride and catechol tests it appears that diphenols and polyphenol oxidase are absent in all stages of differentiation of the cuticle.<sup>14,15</sup>

Evidence that the cuticle protein of *Machilis variabilis* is different and distinct from arthropodin is also seen from amino-acid analysis. Hydrolysis was carried out in 6N hydrochloric acid for 16 hours at 105° C. using a reflux condenser and the hydrolysate chromatographically analysed for the amino-acids using the method of Giri and Rao.<sup>17</sup> The chromatograms revealed 16 amino-acids of which the most prominent spots were those of cystine and glycine; the other amino-acids in the protein hydrolysate are leucine, isoleucine, valine, methionine, tyrosine, proline, alanine, glutamic acid, serine, aspartic acid, lysine, arginine, histidine and threonine. The presence of cystine in the protein of the cuticle together with the results obtained with histochemical tests reported above may indicate that stabilization of protein is by sulphur linkages.

In the occurrence of cystine-stabilized cuticle, *Machilis variabilis* recalls the annectant symphy-

lid *Polyxenella krishnani*<sup>18</sup> which conforms in essential features to the hypothetical ancestral type envisaged by Tiegs and Manton as a possible progenitor of insects.<sup>19,20</sup> In view of the above observations the similarity noted above of the cuticle of *Machilis variabilis* to that of *Polyxenella krishnani* may appear significant, for the Thysanura are considered to be in the main line of evolution of winged insects.<sup>21</sup>

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## ENERGY OUTPUT OF FLARES FROM STARS

**R**ECORDS of results of simultaneous photoelectric and radio observations of flares from certain stars have been reported by Sir Bernard Lovell of Jodrell Bank and Dr. P. F. Chugainov of Crimea Observatory in a communication to *Nature*. These throw light on the energy relationship of the flare events in the visible and radio parts of the spectrum.

The stars on which these observations have been made are UV Ceti, EV Lacertæ and Ross 882. The radio observations were made at Jodrell Bank using the 250-ft. radio telescope

on a frequency of 240 Mc./s. The photoelectric observations were made at the Crimean Astrophysical Observatory, U.S.S.R.

From the reported results two points of interest emerge: (1) that the optical and radio energies involved in small flares on the stars are several orders of magnitude greater than those for the largest type of solar flare; (2) that the ratio of energy output in the radio part of the spectrum compared with the optical continuum is much greater in the flare stars than in the Sun.—(*Nature*, 1964, 203, 1213.)

## THE TERM 'SUPERPARASITISM' IN INSECT PARASITOLOGY

M. J. CHACKO

Indian Agricultural Research Institute, New Delhi-12\*

**A** GLANCE through entomological literature dealing with Insect Parasitology will show that the term 'superparasitism' is being used with various meanings. This is apt to lead one to erroneous conclusions. This term was originally introduced by Fiske (1910) to denote a condition in which "an individual host is attacked by two or more species of primary parasites, or by one species more than once". This definition embraces two distinct phenomena: (1) when the individual host is parasitised by more than one species of primary parasites, and (2) when the individual host is parasitised more than once by the same species of parasite. The former phenomenon was termed 'accidental secondary parasitism' by Pierce in 1908. He later (1910) termed this phenomenon as 'mixed superparasitism', and the other phenomenon as 'cannibal superparasitism'.

Smith (1916) restricted the use of the term superparasitism to "that form of symbiosis occurring when there is a superabundance of parasites of a single species attacking an individual host insect", and introduced the term 'multiple parasitism' for "that form of symbiosis where the same individual host is infested simultaneously with the young of two or more different species of primary parasites". Haviland (1922) suggested the term 'epiparasitism' for superparasitism, and Silvestri (1932) used the term 'hyperparasitism'.

The definition of superparasitism now generally accepted is that of Smith, viz., a superabundance of parasites of a single species attacking an individual host. However, many workers tend to neglect the word 'superabundance'. This has been pointed out by Salt (1934), and Simmonds (1943) also. Simmonds has further pointed out that several workers apply the term superparasitism to the condition normally occurring in species which have many progeny developing at the expense of a single host, and to those cases where variations in the size of the host determine the number of parasite progeny that it will support. He has also stated "this loose application of the term is misleading and 'superparasitism' should be restricted to the

condition that occurs when an individual host receives a greater number of individuals of a single species of parasite than it can nourish to produce normal adults. The emphasis on 'normal' is necessary, because in many species the effect of a low degree of superparasitism is the production of weakly, ill-developed individuals which have their reproductive capacities seriously impaired. This abnormality, it is true, is due to 'superabundance' of parasites within a host, and is, therefore, covered by Smith's definition".

In a number of species of parasites many larvæ develop together within or upon the same host and become normal adults, e.g., larvæ of *Apanteles flavipes* Cameron. This is an example of gregarious parasitism which, however, many workers wrongly call superparasitism. Again, those cases where the number of progeny produced varies according to the size of the host are also referred to as superparasitism, but wrongly. The egg of *Corcyra cephalonica* Stainton is large enough for the normal development of only one individual of *Trichogramma evanescens minutum* Riley. However, several individuals of *Trichogramma* successfully develop into normal adults in the larger egg of *Euproctis lunata* Walker. Superparasitism occurs in these cases only if there is superabundance of parasites, contributing to the production of weakly developed adults which have their reproductive capacity adversely affected.

In some species the development of more than one individual of the parasite in the same individual host is necessary for the successful completion of the life-cycle of the parasite. Flanders (1952) has observed that *Diversinervus smithi* Compere is obligatorily gregarious on *Saissetia oleæ* (Bernard); the host's body contents exceed the food requirement of one parasite and the presence of more than one parasite is needed to consume all the host's contents and thus provide conditions suitable for the pupation of the parasite. This is not superparasitism as there is no superabundance of parasites.

Ulyett (1943) while referring to superparasitism says "in the modern conception of the term, only cases are included in which the same host individual is attacked by more individuals

\* Present address: Commonwealth Institute of Biological Control, Indian Station, Bangalore-6.

of a single species of primary parasite than it (the host) can support to maturity". He has, however, overlooked what Simmonds has emphasised on the word 'normal'. In several cases adults which appear normal are produced from the same individual host. But only studies on their reproductive capacity will show whether these are normal or not. Chacko (1964) has observed that when six or more individuals of *Bracon gelechiæ* Ashmead develop on a full-grown larva of *C. cephalonica*, the adults that are produced appear normal but their reproductive capacity is adversely affected which is an effect of superparasitism. Therefore, even if the host supports the parasites to maturity, they need not be normal always.

So it is clear that while using the term 'superparasitism' one has to exercise a great deal of caution, as indiscriminate use of the term misleads other workers.

The author is grateful to Dr. M. G. Ramdas Menon, Indian Agricultural Research Institute New Delhi, for going through the manuscript and giving valuable suggestions.

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## AUTORADIOGRAPHIC TECHNIQUE IN CANCER CELL STUDY

THE application of the laboratory technique known as autoradiography has enabled in recent years to obtain significant new information regarding cancer cells. The technique, in effect, allows a cell—or part of a cell—to record its own life-cycle in a specially sensitive Kodak emulsion. A piece of plant or animal tissue treated with a radioactive isotope-labelled compound is mounted on a slide which is then dipped into the emulsion under dark-room conditions, dried, enclosed in a light-tight container, and placed in a refrigerator during the exposure period. This is the period during which the radiation given off by the radioactive material strikes the silver halide crystals in the emulsion. After such exposure, the chemical action of a developer can reduce the halide grains to silver crystals which are visible under the microscope as black dots.

The radioactive tracer material used is tritiated thymidine, which is a "nucleoside precursor" of DNA in a cell in that it even-

tually becomes a component part of the nucleus. Since thymidine is used by cells exclusively for DNA synthesis, the tracer can be present only where this synthesis is taking place. DNA is the key component in cell division (mitosis) and the study of DNA has been vital in the study of cancer and other abnormal cell activities.

The radioactive tracer material shows up only in those cells synthesising DNA at the time the radioactive material is injected into the tissue. The percentage of the cells labelled with DNA under the finished slide represents the percentage of cells synthesising DNA at a given time. Thus the rate of cell division in a tissue can be accurately determined.

The use of the newly introduced extremely fine grain emulsion has extended the accuracy and scope of the technique, and, combined with the electron microscope, autoradiography has become an accepted tool of research in cellular biology.—(Courtesy of Kodak Limited.)



## LETTERS TO THE EDITOR

### ABSORPTION CROSS-SECTIONS FOR THE NUCLEAR SCATTERING OF HIGH ENERGY NUCLEONS BY CARBON

Using Glauber approximation as discussed by Gatha and Mathur,<sup>1</sup> an expression for absorption cross-section is determined as

$$\sigma_a = 2\pi \int_0^\infty \xi d\xi [1 - e^{-4\bar{n}_2 \tau(\xi)}] \quad (1)$$

where

$$\tau(\xi) = \int_0^\infty \rho [(\xi^2 + z^2)^{1/2}] dz$$

in which  $\rho(\gamma)$  is the nuclear density distribution for the element and  $(\xi, z)$  are the cylindrical co-ordinates.

A characteristic nuclear density distribution  $\rho(\bar{\gamma})$  for light elements has been determined by Gatha, Shah and Patel<sup>2</sup> and in a revised form by Gatha and Shah<sup>3</sup> on the basis of the experimental data on the nuclear scattering of 340 Mev. nucleons. In this  $\rho(\bar{\gamma}) = \rho(\gamma)$  for all nuclei where  $\bar{\gamma} = \gamma \times A^{-1/3}$ . The above expression for  $\sigma_a$  can now be written as

$$\sigma_a = 2\pi A^{2/3} \int_0^\infty \xi d\xi [1 - e^{-2\gamma_2 \tau(\xi)}] \quad (2)$$

where

$$\tau(\xi) = \int_0^\infty \rho [(\xi^2 + \bar{z}^2)^{1/2}] d\bar{z}$$

with

$$\xi = \xi \times A^{-1/3}, \quad \bar{z} = z \times A^{-1/3}, \quad \gamma_2 = 2\bar{n}_2 A^{1/3}$$

and

$$\bar{n}_2 = \frac{1}{2} [\sigma_{pp} + \sigma_{np}].$$

Substituting  $\rho(\bar{\gamma})$  in the above equation of  $\tau(\xi)$ , the expression for  $\tau(\xi)$  has been calculated for the complete range of  $\xi$ .

In the present investigation, the absorption cross-sections  $\sigma_a$  have been calculated using the above value of  $\tau(\xi)$  for carbon for several energies between 300 Mev. and 970 Mev. by

performing the necessary integration. Theoretically. The values of  $\gamma_2$  have been determined from the experimental values of  $\sigma_{pp}$  and  $\sigma_{np}$  scattering cross-sections for (p, p) and (n, p) scattering respectively. These theoretical values of  $\sigma$  are shown in Table I along with the experimental values.

TABLE I  
Absorption cross-sections in millibarns for various energies

Energy in Mev.	Theoretical	Experimental	Ratio
300	214.9	203 ± 33	1.06
350	208.4	201 ± 30	1.04
420	208.3	210 ± 20	0.99
635	237.8	220 ± 18	1.09
650	239.2	227 ± 12	1.05
765	257.5	220 ± 18	1.15
895	263.3	230 ± 20	1.15
970	264.9	254 ± 37	1.04
		211.9 ± 8.4	

It will be seen from the above comparison that calculated values of  $\sigma_a$  lie within the experimental errors for all energies up to 650 Mev. The agreement is approximate beyond this energy. The deviation in the theoretical value at 765, 895 and 970 Mev. may be due to the meson production at such high energies which influence the values of  $\sigma_{pp}$  and hence  $\gamma_2$ . The agreement between the theoretical and experimental values supports the concept of a characteristic nuclear density distribution on which equation (2) is based.

Physics Department,  
Bhavan's College,  
Andheri, Bombay-58 (AS),  
August 24, 1964.

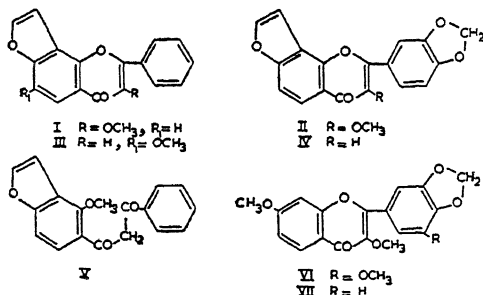
R. H. N. PATEL  
G. Z. GHATA

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# CHEMICAL COMPONENTS OF PONGAMIA PINNATA: SEEDS, FLOWERS AND STEM-BARK

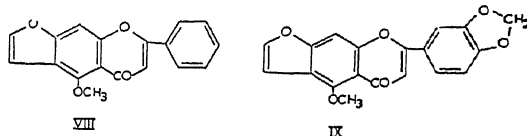
ON account of inherent difficulties, detailed chemical study of plants as an aid to plant classification has been making only slow progress. It may be said in general that where such study has been made it has corroborated the findings of the systematic botanists. At the same time instances have come to light where the chemical study has rightly indicated the need for a revision of the opinion of botanists. One example of this nature is mentioned below.

Intensive study of the various parts of the *Pongamia glabra* have been made on account of their importance in medicine and oil industry. The seeds<sup>1,2</sup> are found to contain four angular furanoflavones, namely, karanjin (I), pongapin (II), kanjone (III) and pongaglabrone (IV) and a diketone pongamol (V), while the roots<sup>3</sup> and stem-bark<sup>4</sup> contain two flavonols of rare types, kanugin (VI) and demethoxykanugin (VII) where all the hydroxyl groups are protected either by methylation or methylenation. Kaempferol<sup>5</sup> and  $\gamma$ -sitosterol have been isolated from the flowers.



*P. pinnata*, an Australian plant, has been reported to possess physiological properties<sup>6</sup> similar to those of *P. glabra* and the names have been considered by certain botanists to be synonymous.<sup>7</sup> In 1952, Row<sup>8,9</sup> reported his study of the chemical components of the roots of *P. pinnata*; he isolated four furanoflavones of which two were angular having a 3-methoxyl group, namely, karanjin (I) and pongapin (II) and the other two linear having a 5-methoxyl group, namely, pinnatin (VIII) and gamatin (IX). This showed difference in chemical composition between the roots of *P. pinnata* and *P. glabra* and there seemed to be need to examine other parts of *P. pinnata* so as to get more data useful for chemical taxonomy. So the seeds, flowers and stem-bark have been obtained by the kind help of Professor A. L.

Reimann of the University of Queensland, Australia, for this purpose.



**Seeds.**—The powdered kernels (100 g.) were extracted with light petroleum (60–80°) in two stages, the first extract made for 50 hr. giving oil A (25 c.c.) and the second made for further 100 hr. yielding oil B (1 c.c.). The defatted seeds were extracted with ethanol which gave a brown viscous oil. The non-fat components of oil A were separated by extraction with ethanol. The ethanol extract on concentration under reduced pressure gave a yellow oil (5 c.c.) which on keeping for three days at 5° deposited a yellow residue. The oil was decanted and the residue (400 mg.) crystallised from methanol as colourless needles, m.p. 191° alone or mixed with an authentic sample of pongapin (II). The decanted oil was dissolved in benzene and passed over a column of alumina. Light petroleum and benzene eluted more pongapin (50 mg.). Ethanol washings of the column gave a brownish-yellow oil (1 c.c.) having an unpleasant smell. Oil B when similarly worked up also gave pongapin.

**Flowers.**—(100 g.) were extracted first with light petroleum followed by ether in soxhlet extractor. The light petroleum extract on working up yielded a waxy material, m.p. 65–70°. The ether extract on evaporation gave a deep yellow residue which crystallised from ethyl acetate-light petroleum (250 mg.), m.p. 265° identified as kaempferol.

The stem-bark contained only waxes and flavonoids were absent.

Table I summarises the results relating to the various parts of the two species of *Pongamia*.

TABLE I

Source	<i>P. glabra</i>	<i>P. pinnata</i>
Seeds	(i) Karanjin and pongamol (ii) Pongapin, kanjone and pongaglabrone obtained in small yield	Pongapin <sup>*</sup> ..
Flowers	.. Waxes, kaempferol and $\gamma$ -sitosterol	Waxes and kaempferol
Roots	.. Kanugin and demethoxy kanugin	(i) Karanjin and pongapin (ii) Pinnatin and gamatin
Stem-bark	Waxes, kanugin and demethoxy kanugin	Waxes only

Though there is some resemblance between the two species as is found in many members of a genus, the differences are many and marked. There is reason therefore for recognising them as two different species of *Pongamia*.

Department of Chemistry,  
University of Delhi,  
Delhi-6, September 14, 1964.

R. N. KHANNA.  
T. R. SESHADRI.

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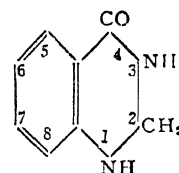
#### DERIVATIVES OF 1,2,3,4-TETRAHYDRO-QUINAZOLIN-4-ONE

DURING the course of our work on quinazolinones, we had occasion to synthesize a number of derivatives of 1, 2, 3, 4-tetrahydroquinazolin-4-ones to ascertain their pharmacological interest.

The tetrahydroquinazolinones reported in this communication were synthesized by condensing *o*-aminobenzamide and its derivatives with

aldehydes and ketones in presence of *p*-toluene sulphonic acid as catalyst. As a proof for the course of condensation of *o*-aminobenzamide with benzaldehyde, the product, 2-phenyl-1, 2, 3, 4-tetrahydroquinazolin-4-one, was oxidised with potassium ferricyanide to 2-phenyl-3, 4-dihydroquinazolin-4-one.

A few typical experiments are described below:



1, 2, 3, 4-tetrahydroquinazolin-4-one

**2-Phenyl-1, 2, 3, 4-tetrahydroquinazolin-4-one.**—*o*-Aminobenzamide (1.36 g.; 0.01 mole) and benzaldehyde (1.1 g.; 0.011 mole) were refluxed in ethanol (10 ml.) containing *p*-toluene sulphonic acid (0.1 g.) for one hour. On cooling the reaction product, a crystalline solid was obtained. It was separated and thoroughly triturated with cold 1N sodium hydroxide solution (10 ml.). It was then crystallised from alcohol; m.p. 216–18° (reported 223–24°). Found: N, 12.51; Calculated for  $C_{14}H_{12}N_2O$ : N, 12.50%.

**2-Phenyl-3, 4-dihydroquinazolin-4-one.**—2-Phenyl-1, 2, 3, 4-tetrahydroquinazolin-4-one (1 g.), potassium ferricyanide (4 g.) and potas-

TABLE I

No.	2, 2	3	6	M.P. °C.	Lit. m.p. °C.	Nitrogen %	
						Found	Calculated
I	—CH <sub>3</sub> , —CH <sub>3</sub>	..	H	177-9	182 <sup>1</sup>	16.06	15.92
II	—CH <sub>3</sub> , —C <sub>2</sub> H <sub>5</sub>	..	H	176-8	183 <sup>1</sup>	14.96	14.73
III	—C <sub>6</sub> H <sub>5</sub> , —H	..	H	216-8	223-4 <sup>1</sup>	12.51	12.50
IV	C <sub>6</sub> H <sub>5</sub> CH=CH—, H—	..	H	224-6	..	11.10	11.20
V	—CH <sub>2</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	..	H	213-5	225 <sup>1</sup>	13.05	12.96
VI	—CH(CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	..	H	175-7	..	11.87	12.17
VII	—CH <sub>2</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> —	..	H	256-3	254 <sup>1</sup>	13.69	13.87
VIII	—CH(CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	CH <sub>3</sub>	H	204-6	..	11.21	11.48
IX	—CH <sub>2</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	..	H	216-8	..	11.00	11.18
X	—CH(CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	..	H	160-3	..	10.39	10.59
XI	—CH <sub>2</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> —	..	H	204-6	..	11.58	11.84
XII	—C <sub>6</sub> H <sub>5</sub> , —H	..	H	246-8	..	10.63	10.83
XIII	C <sub>6</sub> H <sub>5</sub> CH=CH—, —H	..	H	311-3	..	9.51	9.84
XIV	—CH <sub>3</sub> , —CH <sub>3</sub>	..	H	235-7	..	13.08	13.30
XV	—C <sub>6</sub> H <sub>5</sub> , —H <sup>1</sup>	..	C <sub>2</sub> H <sub>5</sub>	142-4	..	9.53	9.77
XVI	C <sub>6</sub> H <sub>5</sub> CH=CH—, —H	..	C <sub>2</sub> H <sub>5</sub>	171-3	..	8.57	8.96
XVII	—CH <sub>2</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> —	..	C <sub>2</sub> H <sub>5</sub>	182-4	..	10.10	10.06

sium hydroxide (2 g.) were refluxed in 50% ethanol (100 ml.) for 8 hours. The reaction product was concentrated to 10 ml. and acidified with acetic acid to obtain the crude title product. It was purified by dissolving in 1N alkali, charcoaling, filtering and acidifying with acetic acid. It was then crystallised from ethanol; m.p. 230-32° (reported 236°<sup>2</sup>). Mixed m.p. with an authentic sample of 2-phenyl-3, 4-dihydroquinazolin-4-one showed no depression. Found: N, 12.42; Calculated for  $C_{14}H_{10}N_2O$ ; N, 12.61%.

2, 2-Tetramethylene-6-chloro-1, 2, 3, 4-tetrahydroquinazolin-4-one. —2-Amino-5-chlorobenzamide (1.7 g.; 0.01 mole) and cyclopentanone (1.7 g.; 0.02 mole) were refluxed in ethanol (20 ml.) containing *p*-toluene sulphonic acid (0.1 g.) for six hours. The reaction product was stripped of solvent *in vacuo*. The residue was triturated with ice-cold sodium hydroxide solution (5%; 10 ml.) to obtain the crude title product. It was crystallised from aqueous ethanol as needles; m.p. 204-06°. Found: N, 11.58; Calculated for  $C_{12}H_{13}N_2OCl$ ; N, 11.84%.

Scientific and Technical S. SOMASEKHARA.  
Research Division, (Miss) V. S. DIGHE.  
Sarabhai Chemicals, S. L. MUKHERJEE.  
Baroda, August 5, 1964.

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### OXIDATION OF $\alpha$ -HYDROXY ACIDS BY CHROMIUM (VI) OXIDE—A LIKELY NEIGHBOURING GROUP PARTICIPATION

THE chromic acid oxidation of lactic, malic and mandelic acids has recently been studied by Bakore and Narain<sup>1</sup> who feel that their rate data fit into the Westheimer mechanism, *viz.*, loss of a proton from a pre-formed chromic acid ester of the hydroxy acid. It has also been established on the basis of deuteration studies that the C—H bond on the secondary carbon atom is broken in the rate-determining step of the oxidation of mandelic acid by chromic acid.<sup>2</sup> We have now investigated the oxidation of the ethyl and benzyl esters of mandelic acid, and also potassium mandelate, in addition to the above three hydroxy acids, in binary solvents containing acetic acid and water in different proportions, under conditions of constant ionic strength and pH. Under these conditions, the oxidation follows a second-order path, being of the first order with respect to the concentration

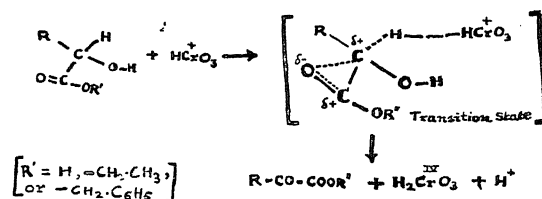
of the hydroxy acid and that of hexavalent chromium. The results obtained by us are given in Table I. The rates for the oxidation of isopropyl alcohol and  $\alpha$ -phenyl ethyl alcohol (from our earlier studies<sup>3,4</sup>) are included in Table I for purposes of comparison.

TABLE I  
 $k_2 \times 10^4$  litre mole<sup>-1</sup> sec.<sup>-1</sup>  
Temp. 45°C.

Compound	% of acetic acid in solvent mixture		
	40	50	60
Isopropyl alcohol	.. 0.2934	0.5665	1.1610
Lactic acid	.. 5.3165	6.2020	7.1150
Malic acid	.. 6.1590	8.3160	10.4500
Mandelic acid	.. 34.9900	45.6200	57.4000
Ethyl mandelate	.. ..	1.3490	1.5280
Benzyl mandelate	.. ..	0.6162	0.7436
Potassium mandelate	.. 35.5100	42.1900	..
$\alpha$ -Phenyl ethyl alcohol	.. ..	3.2920	6.3780

While the observed order mandelic acid > malic acid > lactic acid (which is the same as found by earlier workers) seems to be in keeping with the proton-abstraction theory, the rest of the data cannot be explained on the basis of this mechanism. For, if the introduction of a —COOH group facilitates the oxidation (as against a —CH<sub>3</sub> group in isopropyl alcohol or  $\alpha$ -phenyl ethyl alcohol) the carboxylate anion, as in the mandelate ion, should give a lower rate on account of the +I effect of the —COO— group and the order for the oxidation of esters must correspond to ethyl mandelate < benzyl mandelate < mandelic acid, for the —I effects of these groups are of the order —COOH > —COOCH<sub>2</sub>C<sub>6</sub>H<sub>5</sub> > —COOCH<sub>2</sub>CH<sub>3</sub>. We observe, however, that both mandelic acid and the mandelate ion give approximately the same rate and the ethyl ester is oxidised faster than the benzyl ester.

It is likely that under the conditions of the experiment, at a pH of 3.5, the mandelic acid reacts only as the mandelate anion. The identity of rates for the free acid and the salt seems to indicate this. The anion has also been postulated as the reactive entity in the permanganate oxidation of mandelic acid.<sup>5</sup> The following mechanism is therefore suggested to explain the observed sequence.



The partial negative charge on the carbonyl oxygen of the carboxyl group should be largest in the case of the carboxylate ion, less in the case of the carboxy group and least in the case of the  $-\text{COOCH}_2\text{C}_6\text{H}_5$  group. The stabilisation of the transition state, which has a zwitterionic structure, is therefore largest in the case of mandelic acid, resulting in a large rate enhancement.

While this type of participation by a neighbouring carboxyl group has been postulated for the permanganate oxidations of tertiary hydrogens<sup>6,7</sup> and for the chromic acid oxidations of hydrocarbons at the tertiary carbon atom,<sup>8</sup> we feel that this is the first report of a neighbouring group participation in the oxidation of alcohols.

We would also like to report here that the rate with respect to malic acid is probably not the rate for the total oxidation of the organic substrate, as the malic acid was found to complex with one of the intermediate species of chromium (most probably  $\text{Cr}^{IV}$ ) to give a purple-coloured complex which was stable for over a week. The other compounds do not exhibit such a property.

Dept. of Chemistry, S. SUNDARAM.

Vivekananda College, N. VENKATASUBRAMANIAN.

Madras-4, September 15, 1964.

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### PARAMAGNETIC RESONANCE IN GAMMA IRRADIATED SODIUM DITHIONITE

FREE radical production in wetted sodium dithionite<sup>1,2</sup> ( $\text{Na}_2\text{S}_2\text{O}_4$ ) has been shown by electron spin resonance. Clark *et al.*<sup>3</sup> have detected paramagnetic resonance in x-irradiated alkali dithionites. In the course of a study of the radiation chemistry of alkali thiosulphates<sup>4</sup> and tetrathionates<sup>5</sup> it was found to be of much interest to obtain the electron resonance spectrum of gamma irradiated sodium dithionite.

Chemically pure sodium dithionite ( $\text{Na}_2\text{S}_2\text{O}_4$ ) was irradiated with  $\text{Co}^{60}$ -gamma rays from the

"Gamma Cell 220  $\text{Co}^{60}$  Irradiation Unit" manufactured by the Atomic Energy Commission of Canada Ltd. The unit provided a dose of  $10^5$  roentgens per hour. Fricke dosimetry was used for computing the absorbed dose. The sample was irradiated for 24 hours up to a total absorbed dose of  $1.02 \times 10^{20}$  eV per gram.

The e.s.r. spectrum was obtained with a Varian 4500 spectrometer equipped with an x-band microwave bridge. Magnetic field modulation of 200 c./s. was used. The magnetic field survey in the region of  $g = 2.00$  was calibrated by obtaining the spectra of the semiquinone ion. Phase sensitive detection employed plots the first derivative of the absorption curve. The  $g$  value of the derivative spectrum thus obtained was measured by including microcrystalline D.P.P.H. with the irradiated sample.

The e.s.r. spectrum of gamma irradiated sodium dithionite consisted of a single absorption line, with a  $g$  value of 2.005. The hyperfine lines due to  $^{33}\text{S}$  were not observed. The predominant isotopes of sulphur and oxygen have zero nuclear spins. The line width  $\Delta H$  (width between points of maximum slope taken from the first derivative of the e.s.r. spectrum) was 10.4 gauss at the room temperature. The line width was found to be the same even when the spectrum was drawn at the temperature of liquid nitrogen, although ready power saturation was noticed at the low temperature.

Clark *et al.*<sup>3</sup> reported a  $g$  value of 2.005 and a line width of 11.5 gauss for the e.s.r. spectrum of x-irradiated dithionite. They assume that the  $\text{SO}_2^-$  ion produced by the homolytic fission of the dithionite molecule on irradiation may be responsible for the e.s.r. spectrum. An x-ray structure analysis by Dunitz<sup>6</sup> pictures the  $\text{S}_2\text{O}_4^{2-}$  molecule as consisting of a pair of  $\text{SO}_2^-$  units linked by a weak S—S bond. It is probable that irradiation by x or gamma-rays ruptures the S—S link in the molecule. The fragments may move apart and get trapped in the polycrystalline matrix. The results obtained with the gamma irradiated dithionite support the views of Clark *et al.*<sup>3</sup> Further, it was found that there is much similarity between the e.s.r. spectra of sodium dithionite and alkali thiosulphates, and the radical  $\text{SO}_2^-$  ion is assumed to be present in gamma irradiated crystals of alkali thiosulphates.<sup>7</sup>

The author is grateful to the Department of Chemistry, University of Saskatchewan (Canada), for providing research facilities and financial

assistance. Assistance by Mr. B. C. Green in obtaining the e.s.r. spectra is acknowledged.

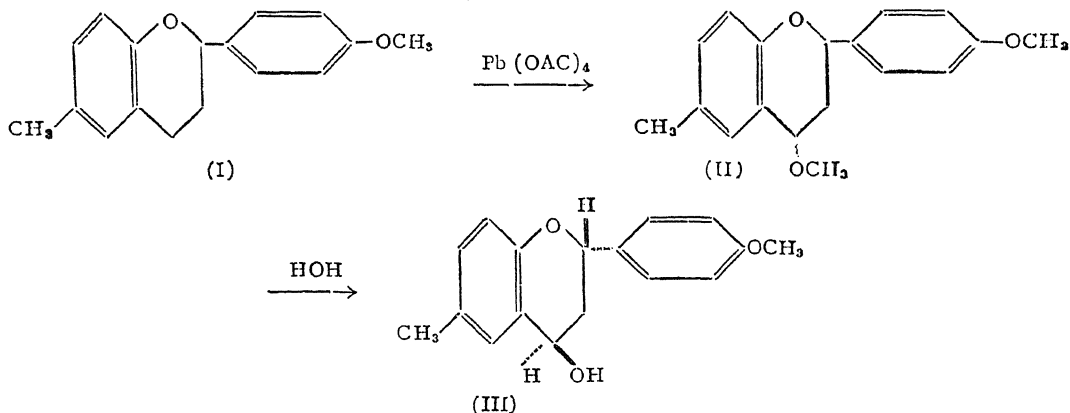
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### SYNTHESIS OF 2, 4 TRANS-6-METHYL-4'-METHOXYFLAVAN 4 $\alpha$ -OL

EARLIER attempts<sup>1</sup> to prepare 6-methyl-4'-methoxyflavan 4 $\alpha$ -ol from 6-methyl-4'-methoxy-4-aminoflavan by the action of nitrous acid have been unsuccessful. We have been successful in getting this compound by the lead tetraacetate oxidation of 6-methyl-4'-methoxyflavan (I)



followed by hydrolysis. The flavan-4-ol so obtained belongs to  $\alpha$ -series which is in conformity with the observations of Bokadia *et al.*<sup>2</sup> Clarklewiss *et al.*<sup>3</sup> established the configuration of the 3-bromo derivatives of flavan 4-ols by N.M.R. measurements and they concluded that flavan 4 $\beta$ -ols may be regarded as 2, 4 *cis* compounds. In view of these observations flavan 4 $\alpha$ -ols may be assigned 2, 4 *trans* configurations. Hence 6-methyl-4'-methoxyflavan 4 $\alpha$ -ol (III) belongs to 2, 4 *trans* series.

6-Methyl-4'-methoxyflavan<sup>4,5</sup> (I) (1.7 g.), dry benzene (60 ml.) and lead tetraacetate (3.4 g.) were refluxed on a water-bath. After 10 hr.

the solution gave negative test for quadrivalent lead. It was then filtered and the filtrate washed with water. The organic layer was separated and dried over anhydrous magnesium sulphate. After the removal of the solvent : yellowish liquid was obtained which was hydrolysed by methanolic caustic potash ( $\text{CH}_3\text{OH}$  10 ml.,  $\text{KOH}$  0.5 g.). The reaction product was filtered hot and most of the solvent was removed under suction pump. The liquid was diluted and extracted with ether. The ethereal extract was worked up in the usual manner to yield a yellowish liquid which crystallised from methanol as colourless needles, m.p. 128–29° (lit. 6 m.p. 127–28°).

Acetylation of the compound (III) was effected in presence of acetic anhydride and pyridine. The solution was kept overnight at room temperature. On dilution a white solid separated which on crystallisation with ethanol gave shining plates, m.p. 110–12°.

The authors wish to thank Dr. W. V. Bhagwat for providing laboratory facilities and one of us (B. L. V.) expresses his thanks to the Council of Scientific and Industrial Research, New Delhi for the award of a research fellowship.

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# IDENTIFICATION OF METHIONINE IN PRESENCE OF VALINE

ALTHOUGH various solvent systems commonly used in paper chromatography of amino-acids were tried by a number of workers,<sup>1-6</sup> these could not resolve the pair methionine and valine—thus making the identification of methionine difficult in presence of valine. Smith<sup>7</sup> has recommended conversion of methionine to methionine sulphone which then runs to an otherwise unoccupied position in the chromatogram. An occasional trace of methionine sulphoxide may however be found even under the carefully controlled conditions recommended in this method.

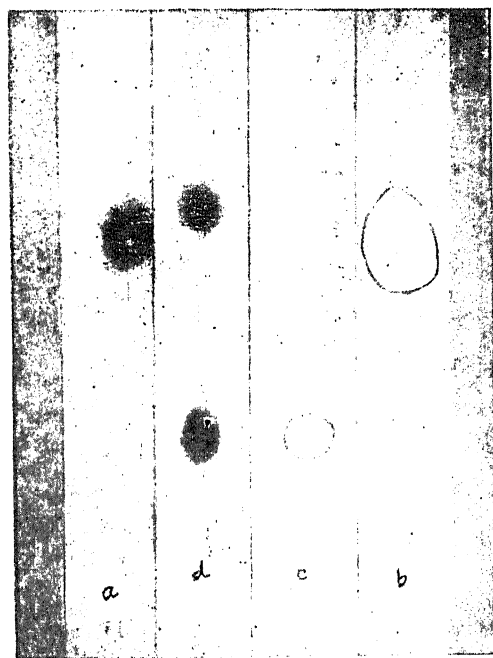


FIG. 1. Unidimensional paper strip chromatography-solvent system butanol : acetic acid : water (60 : 15 : 25). (a) Single spot containing valine and methionine after ninhydrin staining. (b) White spot of methionine against a pink background using location reagent potassium iodoplatinate. (c) White spot of methionine sulphone against pink background using location reagent potassium iodoplatinate. (d) Valine and methionine sulphone after oxidation with  $H_2O_2$  (after Smith).

In this note, an easy method of identification of methionine even in presence of valine is described. Methionine in presence of valine can easily be located by using potassium iodoplatinate for sulphur containing amino-acids.<sup>8</sup> A mixture containing methionine and valine is chromatographed on Whatman No. 1 filter-paper using butanol-acetic acid-water. After chroma-

tography the paper strip is dipped into 0.2% ninhydrin in acetone, and is heated when a single spot on the strip is noticeable which alone cannot help us in an unambiguous identification of either valine or methionine. But if the strip after chromatography is dipped into potassium iodoplatinate reagent, methionine will only react, and will give a white spot against a pink background.

To get more information about the spot that reacts with iodoplatinate, the mixture is oxidised with hydrogen peroxide at 0°C., and the mixture is chromatographed. The strip is now dipped into potassium iodoplatinate. The spot that appeared at the valine position disappears completely, and a new spot at the methionine sulphone position is seen (see Fig. 1).

The advantage of the method outlined in this note is that methionine can be identified even in presence of valine without subjecting the labile sulphur containing amino-acid to rather drastic oxidation procedure. We have seen that the above technique can satisfactorily be used for the identification of methionine present in complex mixture, e.g., plant extracts.

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## DIFFERENTIAL THERMAL ANALYSIS OF BRAZILIAN MINERALS

V. Samarskites

PRELIMINARY notes on metamict minerals from the North-eastern Brazil have been reported by the authors in earlier papers.<sup>1-3</sup> The present paper includes more details on the differential thermal characters of these minerals and also on others from Minas Gerais State.

The samples come from four different localities namely: Alto de Giz near Ecuador, and Fazenda Fidalgo of the Rio Grande do Norte State; Lira in the Paraiba State; and Gruta dos Generosos from Minas Gerais State. The

samples are all dark-coloured, and a powder diagram taken for the first two after heating to 1000° C. for six hours showed distinct identification with samarskites from the A.S.T.M. card index and the data given in earlier publication<sup>3</sup> while the other samples are obtained after identification.

The powdered samples are passed through 200 mesh, and are studied for their differential thermal characters using a Eberbach set where the heating rate is controlled to a 20° C./min.<sup>4</sup> with high intensity. The results are tabulated in Table I, together with the data given by Kulp *et al.*<sup>5</sup> and Orcel<sup>6</sup> for samarskites from different localities.

TABLE I

D.T.A. data on samarskites with peak temperature °C.

Localities	Endothermic	Exothermic
1. Alto de Giz, Ecuador, 280 ..	560 720 ..	
RGN, Brazil W (L)	VW S	
2. Lira, Paraíba, Brazil 200 430 ..	680 ..	
VW (L) VVW	M	
3. Gruta dos Generosos, 165 ..	680 ..	
Minas Gerais, Brazil VW	M-S	
do. ..	720 ..	
	M-S	
5. Fazenda Fidalgo, 220 650 ..	..	
RGN, Brazil W (L) M		
6. Brazil (Kulp <i>et al.</i> ) .. 180 ..	380 720 ..	
W	VW M	
7. Canyon City (Kulp 190 ..	490 720 ..	
<i>et al.</i> ) VW	VW M	
8. Spruce Mine, Dt. 200 ..	460 700 ..	
North Carolina, VW	M M	
U.S.A. (Kulp <i>et al.</i>		
Ref. 3 and 1)		
9. Idem (Idem Ref. 3-2) 800 ..	..	
VVW		
10. „ ( „ 3-3) 180 ..	700 850	
W (L)	V-S M	
11. „ ( „ 3-4) ..	490 720 ..	
	VVW M	
12. „ ( „ 3-5) 205 ..	480 710 760	
VW (L) M	M M M	
13. „ ( „ 3-6) 200 ..	480 ..	
VW (L)	M	
14. U.S.A. (Orcel) 220 ..	480 ..	
W (L)	M	
15. Madagascar ( „ ) 220 ..	700 ..	
W (L)	M	

Intensities: V—Very; S—Strong; M—Medium; W—Weak; L—Large.

From Table I it is clear that all of them show the characteristic exothermic peak at about 700 ± 20° C. which varies in its intensity. Thus this is the point when samarskite attains crystallization. In the data given by Orcel (*op. cit.*) the samarskite from U.S.A. shows no correspondence with this observation, due to the lack of peak at 700° C.

Regarding the other curves, endothermic in nature, it is observed that they have no special significance than being indicators of some absorbed water or due to contamination of some clayey impurities. Interestingly they are reactions covering a wide range of temperature and with no sharp peak temperature. Other impurities are considered to cause more exothermic reactions in the samples. The additional exothermic curve at 560° C. in the sample from Alto de Giz cannot be interpreted on the lines given by Keir and Holland<sup>7</sup> who consider it as due to priorite. These authors further suggest euxenite or eschynite for the exothermics at 750° C. The sample under investigation does not show such peaks as are observed by Kulp *et al.*<sup>5</sup>

The intensities of the peaks in Table I are given by apparent visual observation. It is beyond doubt that they represent the energy for recrystallization in the samples, which is related to the degree of metamictisation.

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#### ON THE SIGNIFICANCE OF THE ANOMALOUS BIAXIAL QUARTZ AND SCAPOLITE IN GRANULITES FROM KODURU, ANDHRA PRADESH

THE calc-granulites in Koduru, Srikakulam District, Andhra Pradesh, consist of calcite, wollastonite, diopside, quartz, scapolite garnet (grossularite), orthoclase, microcline and albite. Apatite sphene, muscovite, pyrite, serpentine, biotite and chlorite are found in minor amounts.

Quartz is granoblastic in the fine-grained rocks, but it is porphyroblastic in medium to coarse-grained rocks, which are usually gneissic. The quartz in some sections is uniaxial, but in others anomalously biaxial. In the latter, biaxial character, the optic axial angle varies from 4° to 17°. The quartz of the granitic rocks in the vicinity is however consistently uniaxial.

Scapolite occurs pseudomorphous after calcite, as segregations with diopside and calcite. It



contains inclusions of calcite, apatite and diopside. Scapolite shows anomalous biaxial nature, the optic axial angle over X varying from 5° to 16°.

The quartz and scapolite in these granulites show anomalous biaxial behaviour. Such anomalous biaxial character has not been so far reported in India, so far as known to us. Examination of synthetic amethyst made by Tsinober and Chentsova shows biaxial character.<sup>1</sup> According to the observations of Tröger the anomalous biaxial nature of quartz has been explained as due to the directional pressure phenomena at high temperature.<sup>2</sup> Further, Krishnan<sup>3</sup> in his work on "Progress in Crystal Physics" suggests that under unidirectional pressure the uniaxial crystal becomes biaxial, unless the pressure direction coincides with the optic axis. Schüller<sup>4</sup> has opined that directed pressure is the essential factor for the stability of the mineral associations in granulite formation.<sup>5</sup> The preliminary results of this work supplements indirect evidence to support the surmise of Schüller that directed pressure prevails during the formation of granulites.

Since the effects of directed pressure have been observed only on scapolite and quartz in granulites, and not on the quartz in the granitic rocks in the vicinity, it is surmised that the formation of the granitic rocks is subsequent to the development of scapolite and quartz.

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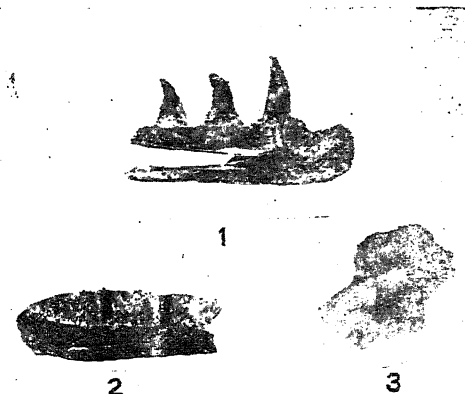
#### A NOTE ON CHASMATOSAURUS FROM THE PANCHET SERIES OF RANIGANJ COALFIELD, INDIA \*

THE author while examining the Panchet rocks of the Raniganj Coalfield during early 1964 collected some fragments of the skeleton of an archaic thecodont, apparently similar to *Chasmatosaurus* Haughton, consisting of parts of lower jaw and pelvis. The fossils were

embedded in the greenish-white sandstones of upper Panchets exposed along the left bank of the river Damodar near the railway bridge about ¾ km. east of Deoli (23° 39' : 86° 53'). They were found associated with the bones of *Lystrosaurus* and labyrinthodonts.

The earliest record of fossil reptiles from the Panchets dates back to 1865 when Huxley<sup>1</sup> described several isolated bones of *Lystrosaurus* and a fragmentary jaw of thecodont which he named *Ankistrodon*. Lydekker<sup>2,3</sup> doubtfully assigned a coracoid to *Ankistrodon* and subsequently referred it to the dinosaurian genus, *Epicampodon*. Later he<sup>4</sup> reassigned it to *Lystrosaurus*. It was von Huene,<sup>5</sup> however, who first suggested the possibility of the jaw of *Ankistrodon indicus* Huxley being of *Chasmatosaurus*.

The three fossil jaws, under reference, are better preserved and are more complete than Huxley's specimen. All of them are from the anteriormost part of the mandible and consist of dentary and teeth. One of these (Fig. 1)



FIGS. 1-3. *Chasmatosaurus* sp. × 1. Fig. 1. Lateral view of the mandible. Fig. 2. Lateral view of the mandible. Fig. 3. Hum.

exhibits three sharply pointed, conical and recurved teeth which are arranged almost in a straight line. The teeth are hollow and compressed somewhat laterally with serrated margins. There are also longitudinal striations visible at the base of the teeth. The other jaw (Fig. 2) bears only three teeth, the tips of which are broken. The mandibles resemble closely with the illustrations given by Broom<sup>6</sup> and Broili and Schroder.<sup>7</sup>

The two pelvic bones in the collection represent the ilia (Fig. 3). Both these are well preserved except for the upper part of the blades which are slightly broken. They appear

to be pseudosuchian and are very similar to the pelvis of *Chasmatosaurus*. So far no articulated skeleton or any other fragment of the post-cranial skeleton of *Chasmatosaurus* is reported from the Panchets. Thus the present find is of considerable interest.

*Chasmatosaurus* is known from the *Lystrosaurus* zone of South Africa and Sinkiang beds of China. Its presence in India in association with *Lystrosaurus* throws additional light on the distribution of these aquatic and semi-aquatic animals in the Gondwanaland during early Triassic times.

The specimens are preserved in the collections of the Geological Survey of India as G.S.I. Types, 18123, 18124 and 18125. A detailed account will be published elsewhere.

The author is thankful to Shri M. V. A. Sastry, Palaeontologist, Geological Survey of India, for his guidance.

Central Palaeontological Labs., P. P. SATSANGI.  
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\*Published with the kind permission of the Director General, Geological Survey of India.

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#### LABELLING OF THE ADULTS OF *CHILO PARTELLUS* SWINHÖE (*C. ZONELLUS*), THE STALK BORER OF MAIZE AND 'JOWAR' WITH RADIOACTIVE PHOSPHORUS ( $P^{32}$ )

ALTHOUGH a number of methods of labelling adults of different insects have been reported there is little information about the labelling of lepidopterous pests. Green *et al.* (1957)<sup>1</sup> and Green and Pointing (1962)<sup>2</sup> obtained radioactive adults of pine shoot moth, *Rhyacionia buoliana* (Schiff), with  $Co^{60}$  in order to study their distribution and dispersal pattern. To take effective control measures against *Chilo partellus* Swinhoe (*Chilo zonellus*), the stalk borer of maize and 'jowar', it is essential to know its behaviour and dispersal pattern. To help us in this study a method of labelling the adults of *C. partellus* (*C. zonellus*) has been perfected which is described in this note.

Fully formed caterpillars of *C. partellus* (*C. zonellus*) were starved for 17 hours. Radioactive phosphorus ( $P^{32}$ ) got from the Atomic Energy Establishment, Trombay, Bombay, was used for labelling the adults of *Chilo*. The radioactive material was diluted to give 100 microcuries activity in 1 ml. Fresh maize stems were split open with a field knife, and in each stem a small cavity was scooped into which 0.10 ml. (i.e., 10 microcuries) of radioactive solution was applied with a micro-tuberculin syringe. A starved caterpillar was liberated in the scooped portion and the second split half of the stem was replaced and tied with a rubber band. These caterpillars were then allowed to feed for 2 hours. They were washed thoroughly with water to remove surface contamination and then assayed for radioactivity. Fresh untreated maize stems were provided to them for further development. Each radioactive pupa was separated and kept in a specimen tube for the emergence of the adult. The activity of the adult moth was also recorded on emergence.

These moths were then separated into males and females. Each pair was kept separately for mating and egg-laying in small 15 × 10 cm. glass rearing jars lined on all the sides with white paper. The females oviposited on these papers. The egg masses were then separated out, placed on an aluminium planchette and assayed for radioactivity. They were transferred to glass rearing jars for hatching. The eggs hatched within 4-6 days. On hatching 5 first instar caterpillars were taken and killed with benzene fumes. They were then kept on an aluminium planchette and assayed for radioactivity. The initial radioactivity ranged between 33 cpm and 53 cpm. Later on the activity of 10 second instar caterpillars was recorded individually. These caterpillars were kept separately and given fresh maize stems (tender shoots) as food for further development. Radioactivity in the subsequent instars (second to fourth) ranged, on an average, from 29 cpm to 6 cpm whereas, in the adults it ranged between 2828 cpm and 22759 cpm. Furthermore, when the adults were allowed to mate they laid fertile eggs with sufficient detectable radioactivity. It is important to note that the activity could be recorded not only in the adults but also in the subsequent generation up to 4th instar caterpillars. This observation will be useful in undertaking studies on the flight range and dispersal pattern, and they will not only be limited to the recovery of the liberated adults but also, in case where the adults escape recovery, the range of flight,

etc., will be determined by the location of the radioactive egg masses or the caterpillars which retain radioactivity up to the 4th instar.

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Division of Entomology, SNEHAMOY CHATTERJI.  
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# ON THE DIVERSITY IN THE DEVELOPMENT AND ORGANIZATION OF STOMATA IN *PHYLLODORA MICHX.*

THE occurrence of more than one type of stomata in different organs of the same plant or sometimes side by side in the same leaf is well known.<sup>1,2</sup> However, to the best of our knowledge there is no record of a plant which shows four main types of stomata with numerous variations in the organization of the stomatal apparatus as we describe hereunder in the leaves of *Phyllodora Michx.*

The leaves of the plant are amphistomatic having evenly scattered and irregularly orientated stomata. By far, the great majority of them are diacytic (48%), but quite a few are paracytic (11%), anisocytic (4%) or anomocytic (3%). In addition to the normal pair of subsidiary cells, its diacytic (caryophyllaceous) or rubiaceous (paracytic) stomata may often show one or two additional (encircling) cells placed parallel or almost parallel to the subsidiary cells (see Fig. 1, A, B, C, J). Other stomata may be typically anisocytic with three unequal cells around the two guard cells (see Fig. 1, G). The most interesting variation of the diacytic or the rubiaceous types are stomata (about 32%) with or without an encircling cell but with the guard cells and the pore placed at various oblique angles to the two subsidiary cells, the guard cells being neither perfectly parallel nor at right angles to the subsidiaries (see Fig. 1, D, E, F and J). We regard such stomata as transitional between the caryophyllaceous and rubiaceous types.

About 1-2% of the diacytic, paracytic or transitional stomata (with oblique guard cells) are enclosed by an anisocytic ring of three encircling cells (see Fig. 1, L). Very rarely there may be a stoma which is girdled round on three

sides by a single crossed epidermal cell as in some ferns (see Fig. 1, I). Presumably, this is the result of the suppression of an earlier division in a diacytic stoma.

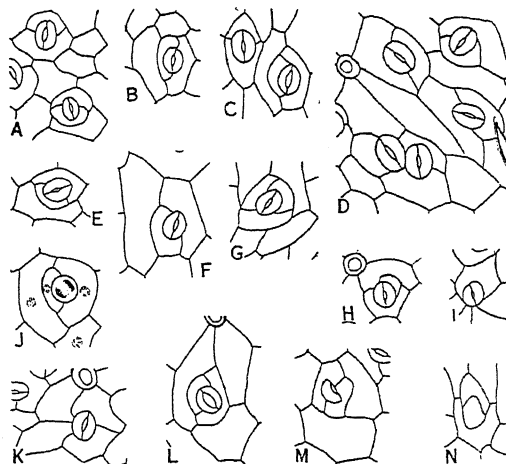


FIG. 1. A-N. *Phyllodora Michx.* A, Diacytic stoma with and without an encircling cell; B, A rubiaceous stoma; C, A diacytic stoma with narrow subsidiaries (left) and a rubiaceous stoma with an encircling cell (right); D, Transitional and contiguous stomata; E, Transitional stoma with an encircling cell; F, Transitional stoma with a triangular subsidiary cell which is in contact with a perigene epidermal cell; G, Anisocytic stoma; H, Diacytic stoma with two very unequal subsidiaries and an encircling cell; I, Fern type of stoma girdled on three sides by a single crossed subsidiary; J, Developing transitional stoma with the guard cell mother cell showing an obliquely placed spindle; K, Anomocytic stoma; L, Transitional stoma with an anisocytic ring of encircling cells; M, Abnormal stoma with a single guard cell; N, Stoma arrested at the mother cell stage. J, x 300; rest, x 150.

We have confirmed that the development of the different types of stomata in *P. nodiflora* is generally mesogenous conforming either to the caryophyllaceous type of *Asteracantha*,<sup>3</sup> rubiaceous type of *Drimys*<sup>4</sup> or anisocytic type of *Notonia grandiflora*.<sup>5</sup> However, the fern type of stomata are apparently mesoperigenous<sup>6</sup> and the ranunculaceous ones (see Fig. 1, K) perigenous.

Abnormalities noticed include contiguous stomata (see Fig. 1, D), stomata with single guard cells (see Fig. 1, M) and stomatal meristemoids which have been arrested in various stages of development and matured into epidermal cells (see Fig. 1, N). The arrested structures are possibly laggards in the last generation of the meristemoids whose development was prematurely cut short by the maturation of the leaf.

The remarkable variations shown by the stomata of *P. nodiflora* seemingly appear to be dependent on (i) the stomatal meristemoid

having three, two or one cutting face, (ii) its having at first three cutting faces and later two (in stomata showing a rubiaceous or caryophyllaceous apparatus enclosed by a ring of three unequal cells), (iii) the number of divisions a meristemoid undergoes or (iv) the plane of the last division (in the guard cell mother cell) in relation to the planes of earlier divisions.

The occurrence of so many different types of stomata in the same leaf may, at first sight, raise strong doubts about the taxonomic value of this character. But while this may be true for plants where the stomatal form is variable, there are other plants, families and even higher taxa whose stomatal organization is unmistakably constant, e.g., Gramineae, Cyperaceae, and the monocots in general<sup>7</sup> and in these it could still be used with advantage. The constancy of the stomatal characters or their range of variation must, therefore, be tested in different taxa before they are used for taxonomic determinations.

We are thankful to the C.S.I.R., New Delhi, for financial aid.

Department of Botany,  
The University,  
Allahabad, May 11, 1964.

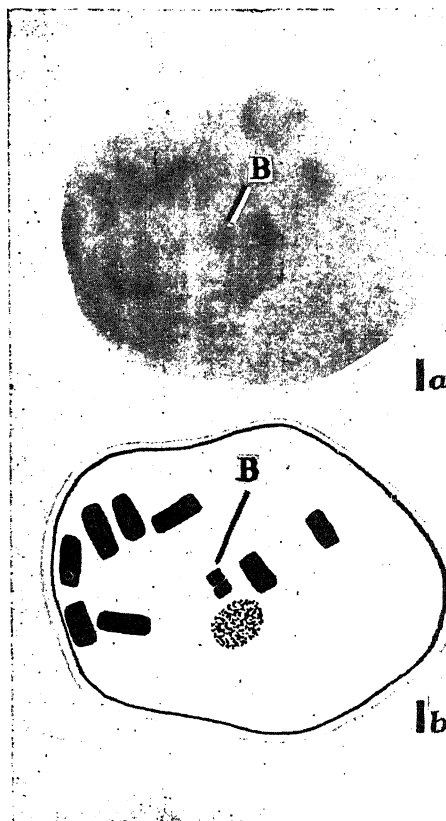
D. D. PANT.  
PARVEEN KIDWAI.

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### TRIGONELLA FOENUM-GRÆCUM, B-CHROMOSOMES

WHILE undertaking the artificial induction of polyploidy in *Trigonella foenum-græcum* it was observed that certain cells in the root tips of the germinated seeds showed the presence of B-chromosomes. Detailed cytology of *Trigonella foenum-græcum* and its interrelationship with the allied genus *Melilotus* has been worked out by Bhattacharyya (1959). The B-chromosomes were absent in his material. Hence more root tips were analysed to study the behaviour of these accessory chromosomes. The B-chromosomes clearly showed median constriction. While studying meiosis one plant revealed B-chromosomes in pollen mitosis (Figs. 1 a and b).

It may be mentioned that the frequency of plants possessing the B-chromosomes is very low. The study of root tips revealed very few cells showing B-chromosomes, but the plant which had B-chromosome in pollen grain had it in practically every grain.



FIGS. 1 a and 1 b. Photomicrograph and camera lucida diagram showing 8 A-chromosomes and a B-chromosome in pollen mitosis.

The behaviour of B-chromosomes in the pollen grains has been studied in detail. At prophase while rest of the chromosomes are long indicating little signs of condensation the B-chromosome is quite condensed and no appreciable change in its size was noticed at later stages. At prometaphase the A-chromosomes are condensed and show clear constrictions. As observed in the root tips the B-chromosome has a median constriction here also. When the A-chromosomes form the metaphase plate the B-chromosome also comes and orients itself on the plate like rest of the complement. It may be further added that at anaphase it shows normal disjunction like the rest of the chromosomes and two daughter B-chromosomes reach the opposite

poles and are included in the telophasic nuclei. No B-chromosome was observed lagging and hence the chances of its elimination were far too remote in the present case.

Muntzing and Nygren (1955) studied the diploid strain of *Poa alpina* from Ardez in Switzerland and found supernumerary chromosomes at meiosis which are not present in the root tips. However in contrast to their observations we have found B-chromosomes in the root tips as well as the pollen grains which are the direct transformation product of meiotic cycle and hence give indirect evidence of their presence in the PMCs. Since the accessory chromosomes of *Trigonella* have a perfectly normal mitotic behaviour in the pollen grains it cannot be said that their centromeres do not function normally but during differentiation of root tissue some factor or condition makes it difficult or impossible for the accessories to react normally with the spindle. This may explain the occurrence of B-chromosomes in practically every pollen grain and only a few cells in the root tissue.

As regards the origin of the B-chromosomes animal kingdom provides evidence that they are derivatives of sex chromosomes. Melander (1950) and Virkii (1954) have reported cases in which certain chromosomes lie more or less on the border line of the typical sex chromosomes and the accessory chromosomes. Sorsa (1956) has reported the disturbance of sex determination in *Sphagnum* due to the presence of many accessory chromosomes ultimately leading to monoecious plants. However the finding provides evidence that as in the animals the accessory chromosomes in mosses may be derived from sex-chromosomes. Several workers believe in the origin of B-chromosomes by fragmentation of A-chromosomes. In *Oenothera* and *Caltha* Cleland (1951) and Reese (1954) obtained data which support this hypothesis. In *Caltha palustris* Reese (1954) actually observed certain small A-chromosomes undergoing misdivision and giving rise to two telocentric small chromosomes which look and behave like the ordinary B-chromosomes occurring in this species. Unlike such accessory chromosomes in *Xanthisma texanum* described by Berger and collaborators (Berger and Witkus, 1954; Witkus, Lofey and Berger, 1955) the B-chromosomes in *Trigonella foenum-graecum* have a median constriction and hence the postulation of origin by fragmentation is not valid in the present material.

The B-chromosomes are shown to have some

relationship with the ecological conditions (Lemis, 1953). Frost (1958) from a study of a large sample of *Centaurea scibiosa* from Sweden and other parts of Europe found a marked East-West difference in the frequencies of accessory chromosomes. This geographical difference largely coincides with a difference in humidity, the frequency of accessory chromosomes being higher in the arid regions. However, Frost has concluded that the selective forces have probably played greatest role in this differentiation. On comparative basis the humidity around Lucknow is much lower than at Calcutta which lies in the region of heavy rainfall. It is quite possible that the B-chromosomes may be absent in *Trigonella* plants growing in certain regions of India and present in others, but only a detailed study can clarify this problem.

As regards the morphological characters of plants having B-chromosomes there was no apparent change in the general appearance of the plant. Seeds of the plants having B-chromosomes have been collected and their progeny is under investigation.

Cytogenetics Lab.,  
Botany Department,  
Lucknow University,  
Lucknow (India), February 7, 1964.

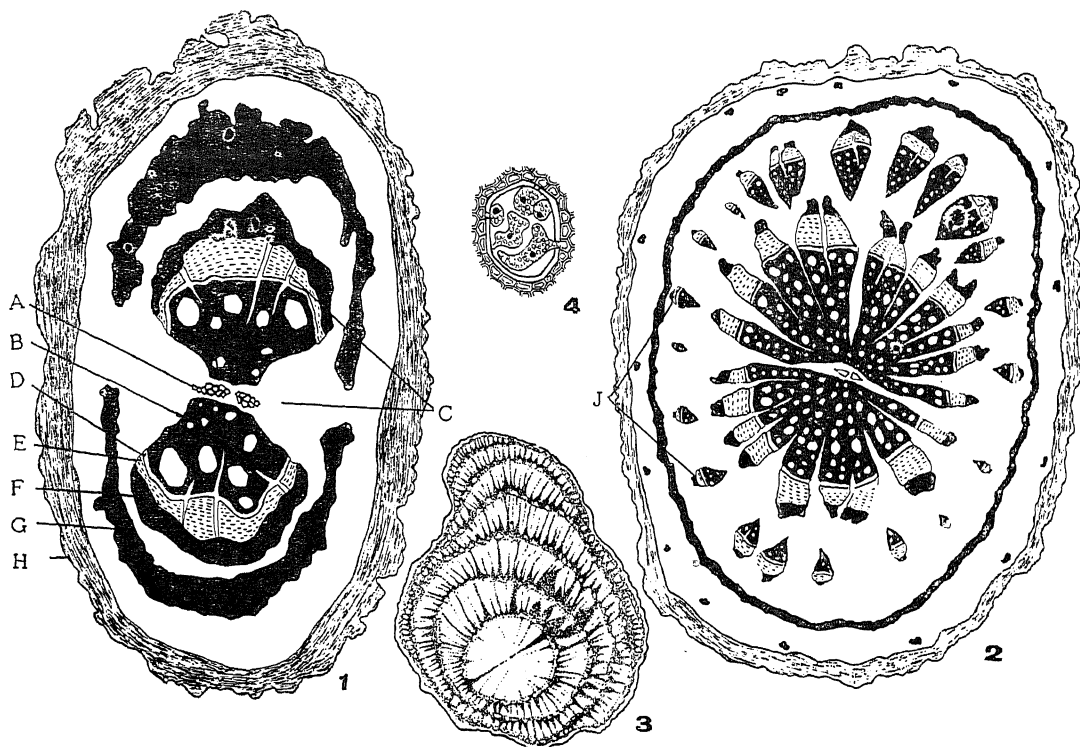
S. S. RAGHUVANSHI,  
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#### ANOMALOUS SECONDARY THICKENING IN THE ROOTS OF *GNETUM ULA* BRONGN.

AN account of the anatomy of the roots of *Gnetum gnemon* has been given by Maheshwari and Vasil.<sup>1</sup> As far as the writer is aware, there is no detailed account on the anatomy and the nature of secondary thickening in the roots of *G. ula*. A study was, therefore, undertaken from the material collected from Cool Heights, Visakhapatnam District, Andhra Pradesh.

The root is diarch. Each of the two primary xylem bundles consists of eight to ten elements. In the thinner roots the secondary thickening



FIGS. 1-4. Fig. 1. T.s. thinner root showing normal secondary thickening,  $\times 60$ . Fig. 2. T.s. root showing the first ring of vascular bundles,  $\times 5$ . Fig. 3. T.s. old root showing successive ring of vascular bundles,  $\times 1/2$  Nat. size. Fig. 4. A tylose,  $\times 107$ . A, Primary xylem; B, Secondary xylem; C, Rays; D, Cambium; E, Phloem; F, Phloem fibres; G, Cortical fibres; H, Cork; J, Ring of vascular bundles.

follows a normal course (Fig. 1) as in *G. gnemon*. However, the phellogen originates from the parenchymatous cells of the cortex and not in the pericycle as in most dicotyledonous plants. The rays are broad and consist of thin-walled parenchymatous cells rich in starch grains.

When the root has attained a thickness of about 7 mm., new cambia arise at various points in the cells of the cortical parenchyma. Gradually these areas become incorporated into a cylinder and produce wedge-shaped collateral vascular bundles as in the stem. The primary xylem is clearly distinguishable up to this stage (Fig. 2). Sooner or later, the growth of the first ring of vascular bundles ceases, and simultaneously another ring of vascular bundles begins to form outside it. Successive rings of vascular bundles are thus formed from the cortex but some of them remain incomplete resulting in an eccentric arrangement of the successive rings (Fig. 3). This type of anomaly extends throughout the older roots.

It is interesting to note that some of the xylem vessels in the secondary wood show conspicuous

tyloses, a feature not observed in the wood of the stem. Each tylose has a nucleus and numerous starch grains (Fig. 4). On wounding, the older roots extrude a gummy substance. The stems too show this feature after attaining a girth of about 40 inches.

The anomalous secondary thickening in the stem of climbers like *G. ula* is usually considered as an adaptive feature but it may not be regarded similarly in the root. That a single plant like *G. ula* should exhibit both adaptive and non-adaptive types of anomaly in the stem and root is something incomprehensible and may have to be considered perhaps as genetic.

Thanks are due to Drs. C. R. Metcalfe, P. Maheshwari and J. Venkateswarlu for their interest and suggestions.

Biology Department, B. S. M. DUTT.  
A.N.R. College, Gudivada, June 22, 1964.

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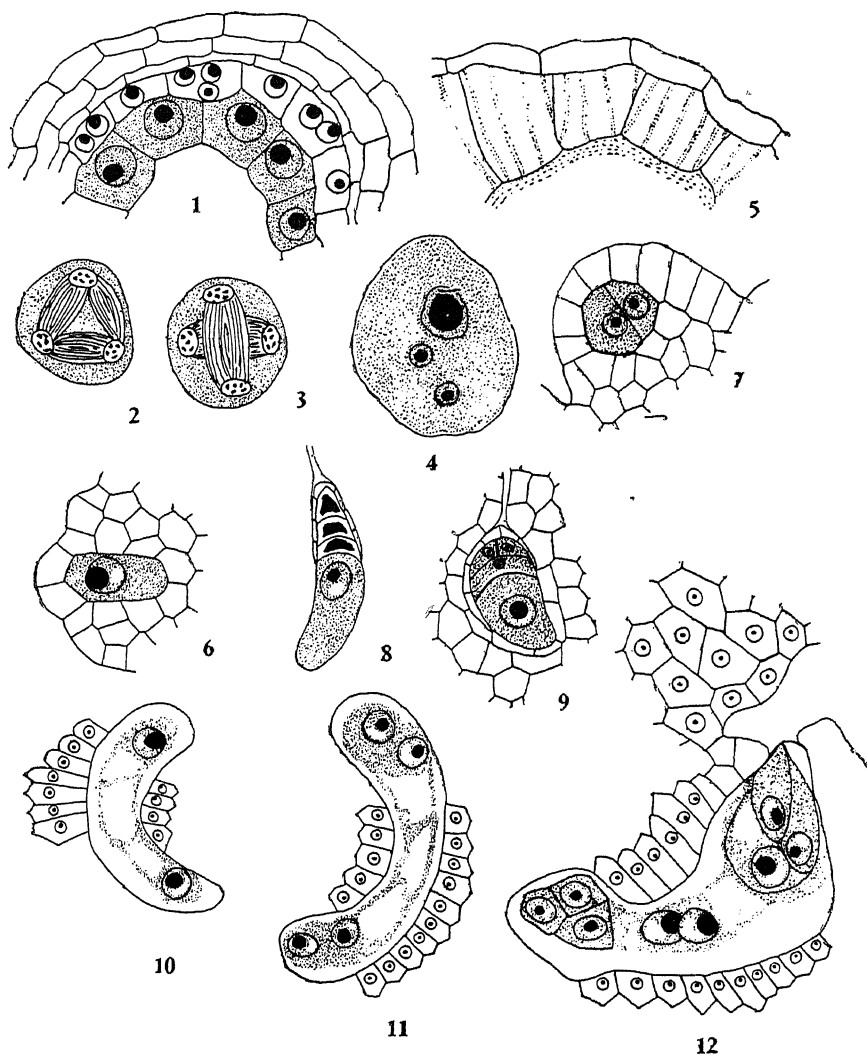
# A CONTRIBUTION TO THE EMBRYOLOGY OF *UTRICULARIA* *WALLICHIANA* Wt.

WYLIE AND YACOM (1923), Kausik (1938), Khan (1954), Kausik and Raju (1955), Shivaramaiah (1964) have reviewed the previous literature on the embryology of the genus *Utricularia*. The present communication deals with the embryology of *Utricularia wallichiana*.

The material was collected round about Bangalore, and fixed in F.A.A., dehydrated and embedded in paraffin wax according to the

customary practice. Sections were cut at 8-12  $\mu$  and stained in Heidenhain's hæmatoxylin.

A transection of a young anther lobe shows an epidermis, endothecium, a middle layer and tapetum surrounding the microspore mother cells. Tapetal cells are uninucleate in the beginning but later becomes bi- and tri-nucleate (Fig. 1). The microspore mother cells undergo meiotic divisions to form tetrads of microspores. The microspores are tetrahedral and decussate in arrangement (Figs. 2-3). The mature pollen grain is 3-nucleate (Fig. 4), as in *Utricularia*



FIGS. 1-12. Fig. 1. T.S. of young anther lobe showing microspore mother cells surrounded by tapetum, a middle layer, endothecium and epidermis,  $\times 1,200$ . Figs. 2 and 3. Tetrahedral and decussate arrangement of microspores,  $\times 1,500$ . Fig. 4. 3 nucleate pollen grain,  $\times 1,500$ . Fig. 5. Portion of an anther lobe showing fibrillar endothecium,  $\times 1,200$ . Fig. 6. Ovule with single hypodermal archesporial cell,  $\times 1,200$ . Fig. 7. Ovule with twin archesporial cells,  $\times 1,200$ . Figs. 8 and 9. Linear and T-shaped tetrads of megaspores,  $\times 1,200$ . Figs. 10-12. Stagers in the development of Embryo-sac,  $\times 1,200$ .

*flexuosa* (Khan, 1954). The anther at the time of dehiscence exhibits fibrillar endothecium (Fig. 5).

The ovary is superior and unilocular. The ovules are indefinite, anatropous, unitegmic, tenuinucellate and are arranged on the flattened massive central placenta. There is single hypodermal archesporial cell, but occasionally two archesporial cells are met with (Figs. 6-7). The archesporial cell directly functions as the megaspore mother cell. The megaspore mother cell by meiotic division gives rise to linear and T-shaped tetrads of megaspores (Figs. 8-9), as in *Utricularia flexuosa* (Khan, 1954). The chalazal functioning megaspore by three successive divisions gives rise to an octonucleate embryo-sac of the Polygonum type (Figs. 10-12). The fully formed embryo-sac is curved with a broad micropylar and tapering antipodal end. The micropylar end of the embryo-sac protrudes beyond the ovule and comes in contact with the placental nutritive tissue. A conspicuous integumentary tapetum develops in the middle of the embryo-sac.

My thanks are due to Prof. S. Shamanna for his valuable suggestions and to Rev. Fr. E. D'Souza, S.J., Principal, for his encouragement. My thanks are also due to the Systematic Botanist, Coimbatore, for kindly determining the species.

Department of Botany, G. SHIVARAMIAH.  
St. Joseph's College,  
Bangalore-1, July 6, 1964.

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#### ON THE OCCURRENCE OF THE ANEMONE PHYTOCOETEOPSIS RAMUNNI PANIKKAR IN THE COCHIN BACKWATER

WHILE making a faunistic study of the Cochin backwater, an interesting species of anemone was observed in shallow regions partially buried in a deposit formed of silty sand. This was later identified as *Phytocoeteopsis ramunni* Panikkar. Panikkar (1936) first recorded the above species from the brackish water of Adyar lake in Madras. Altogether eighteen specimens were obtained and a close study revealed that the specimens collected from the Cochin back-

water agree with type specimens from Adyar. However, in the present locality the anemone seems to show a preference to a fine sandy bottom and it was absent in muddy deposit and at a bottom formed of decaying leaves and twigs. The anemones were collected using crowbar, but some of the specimens broke lengthwise along the inter-mesenterial region and recoiled, exposing the ripe gonads.

In the Cochin backwater, the salinity of the water varied from 0.40% to 34.00% and *P. ramunni* was found to occur in the locality only during November to May when the salinity was above 20%.

An attempt was made to study the salinity tolerance of *P. ramunni* and specimens of lengths up to 15 cm. were introduced in a table aquarium of size 2' x 1' x 1'. A layer of deposit obtained from the lake where the anemone is generally found was spread in the aquarium and 8 specimens were planted in small burrows after filling the tank with lake water in December 1953 when the salinity was 28.75%. Everyday about one-third of the water in the tank was replaced by lake water; thus the salinity was gradually lowered to 0.40% during June and July when five of the specimens died, while the remaining ones were found retracted into the burrows. However, in the following months when the salinity of water in the tank increased the survived ones became active and appeared to lead a normal life. The anemones were fed with plankton and artificial food like fat of cockroaches.

I thank Dr. C. V. Kurian for his encouragement and Dr. N. K. Panikkar for his help in the identification of the specimen.

W.P. Branch, P. V. CHERIYAN.  
Forest Research Institute,  
Dehra Dun, July 6, 1964.

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#### ON SOME NEW RECORDS OF PARASITES OF *HYPERA POSTICA* (GYLLENHAL) (COLEOPTERA : CURCULIONIDAE) \*

IN India *Hypera postica* (Gyllenhal), the lucerne weevil, had been collected on a large number of fodder crops such as 'lucerne' (*Medicago sativa*), 'Senji' (*Melilotus alba*), *Lathyrus hirsuta*, 'trefoils' (*Trifolium alexandri-*



num) and a weed locally called as 'Akta' in Pusa (Bihar). The pest though sporadic sometimes becomes serious.

Systematic survey and collection of various stages in the growth and development of the pest was made under the PL-480 Scheme for Survey of Beneficial Parasites and Predators of crop pests, with a view to collect the natural enemies. This note summarises the results of the field collections and the rearing of parasites in the laboratory from different host stages during December 1963 to April 1964 in the I.A.R.I. Estate. Since April 1964 unsuccessful attempts were made to collect either the adults or the immature stages of the lucerne weevil in Delhi and Bulandshahr (Uttar Pradesh) areas. The parasites that emerged from the Delhi area collections have been identified as: (i) *Bathyplectes exiguus*? (Gravenhorst), (ii) *Necremnus leucarthros*? (Nees) and (iii) *Habrocytus* sp. The occurrence of and the parasitisation of *Hypera postica* (Gyll.) by these three parasites is being recorded for the first time not only from India but from the Oriental Region.

*Bathyplectes* sp. (Ichneumonidae: Hymenoptera).—This parasite has been identified as very closely related to *B. exiguus* (Gravenhorst). It parasitises only a very small percentage of weevil population as evidenced from the following figures: Out of 2,647 grubs collected from the field from middle of February to middle of March 1964, only seven adults of *Bathyplectes* emerged successfully and four more parasites remained in their pupal stage. The pupæ of *Bathyplectes* are oblong-oval, brownish testaceous with a central yellowish band. Further studies on the biology of the parasite, percentage parasitism and the causes of its low percentage of parasitism is under study. Earlier a pale-arctic species, *Bathyplectes curculionis* (Thomson), had been reported to be parasitising *Hypera brunneipennis* (Boheman) (Bosch, R. von den and Dietrick, E. J., 1959 and Dietrick, E. J. and Bosch, R. von den, 1953) and hence was imported (Chamberlain, 1926) into the United States against *Hypera postica*. Hamlin *et al.* (1949) and Michelbacher (1940) reported it as being of considerable importance in the biological control of *Hypera postica* in the United States and parts of Northern California.

*Necremnus* sp. (Eulophidae: Hymenoptera).—This parasite was reared from the field-collected pupæ during the month of March 1964 and has been identified as very closely related to the

species *leucarthros* (Nees). Out of 1,271 field-collected pupæ as many as 152 parasites emerged. Further, the mature grubs, just before pupation, were subjected to these parasites in jars in the laboratory. These parasites bred successfully on the natural host. The culture could not be maintained in April 1964 as there was no pest infestation in the fields of lucerne and other fodder crops round about Delhi. The pupæ collected during the first fortnight of April were not parasitized. Earlier Gahan (1941) described *Necremnus oregonensis* reared from the pupæ of *Hypera rumicis* (L.) and *N. breviramulus* from the pupæ of *H. eximis* Lec. and *H. compactus* (Say) in the United States.

*Habrocytus* sp. (Pteromalidae: Hymenoptera).—Only 21 specimens of this parasite were reared out of 855 field-collected pupæ of *Hypera postica*. Earlier, this parasite has been reported as a hyperparasite of the genus *Bathyplectes* especially the species *curculionis* (Thomson) and *exiguus* (Gravenhorst) (Muesebeck, C. F. W. *et al.*, 1951) both of which were reared from different species of the genus *Hypera* (which do not occur in India) in the United States. Further studies are in progress to ascertain the exact relationship of the parasite in relation to the host.

The authors are grateful to Dr. S. Pradhan for his keen interest in these studies.

Division of Entomology,	B. R. SUBBA RAO.
Indian Agricultural	BALDEV PARSHAD.
Research Institute,	ATMA RAM.
New Delhi, July 16, 1964.	R. P. SINGH.
	M. L. SRIVASTAVA.

\* Contribution No. 3 from the Scheme for Survey of Beneficial parasites and predators of agricultural crop pests in the Indian Union (PL-480).

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## REVIEWS

Italian Physical Society—Proceedings of the International School of Physics "Enrico Fermi", Varenna, Italy. (Published by the Academic Press, Inc., 111, Fifth Avenue; New York-3, New York, U.S.A.)

Course 26: *Elementary Particles*. Edited by M. Conversi, 1964. Pp. 264. Price \$10.00.

The course ran from July 23 to August 4, 1962 and its Director was M. Conversi, and it was attended by eighty-two persons. The subject-matter of the course was covered in four sections. The first section was on "New Mesons and Resonances in Strong Interactions" and the following were the speakers: A. H. Rosenfeld—Strongly interacting particles and resonances; J. J. Sakurai—New mesons and resonances in strong-interaction physics. Theoretical. The second section was on "Selected Topics on Strange Particles" and the following were the speakers: F. S. Crawford—Strange-particles decay; H. K. Ticho—Strange-particle resonances. The third section was on "Form Factors of Elementary Particles" and S. Drell spoke on that subject. The fourth and concluding section was on "Miscellaneous Subjects" and the following were the speakers: D. Atkinson—Prediction of pion phases by dispersion relations; P. Franzini—Determination of the  $\mu$ -neutrino helicity; R. Gatto—The two neutrinos; M. G. N. Hine—The CERN proton synchrotron, 1954-1962; forecast and reality compared.

Course 27: *Dispersion and Absorption of Sound by Molecular Processes*. Edited by D. Sette. 1964. Pp. 443. Price \$17.00.

The course ran from August 6 to August 18 1962, and its Director was D. Sette. It was attended by sixty persons. The subject-matter of the course was covered in a series of lectures and the following were the speakers and the respective topics dealt with by them: K. F. Herzfeld—Theory of fluids; H. O. Knezer—Relaxation thermique dans le gas; M. Greenspan—Translational dispersion in gases; J. Lamb—Dispersion and absorption of sound by molecular processes: thermal relaxation in liquids; T. A. Litovitz—Ultrasonic relaxation in liquids; K. Tamm—Acoustic relaxation in electrolyte solutions; W. P. Mason—Absorption and dispersion of sound in polymer solutions, polymer liquids, rubbers and solid polymers; K. F. Herzfeld—Theories of relaxation times; H. J.

Bauer—Phenomenological theory of multiple relaxation processes; C. G. Sluijter—Rotational relaxation in the sound absorption of hydrogen isotopes; R. T. Beyer—Measurements of ultrasonic velocity and absorption in liquids at high frequencies, at high temperatures and under high hydrostatic pressure; R. T. Beyer—Measurements of ultrasonic velocity and absorption in liquids under high sound intensities; L. Liebermann—Determination of the kinetics of chemical reactions by sound absorption or dispersion; J. M. Stevels—The dielectric properties of quartz crystals and fused silica in relation to their imperfections; R. W. B. Stephens—Ultrasonic attenuation in liquid metals; A. J. Kovacs—Recouvrance of volume des verres; comparaison entre les expériences et une théorie phénoménologique; A. J. Kovacs and J. D. Ferry—Variations des paramètres viscoélastiques du polyacétate de vinyle dans le domaine de sa transition vitreuse; P. G. Bordoni—Relaxation of lattice imperfections in solids.

C. V. R.

*Experimental Chemotherapy, Volume II*. Edited by R. J. Schnitzer and Frank Hawking. (Academic Press, Inc., 111, Fifth Avenue; New York-3, New York, U.S.A.), 1964. Pp. xvii + 614. Price \$23.00.

The volume under review presents a series of discussions on the broad field of chemotherapy of bacterial infections. Featured are the chemistry, antimicrobial action, and toxicology of antibacterial agents. After an introductory chapter by C. H. Browning, Paul Ehrlich's co-worker, describing the early history of antibacterial therapy with dyestuffs, the contributing authors, all specialists in their fields, discuss the various groups of active compounds on the basis of their own experimental work. The individual articles are listed below: (1) Chemotherapy with Antibacterial Dyestuff by C. H. Browning; (2) The Mode of Action of Some Antibacterial Substances by H. J. Rogers; (3) Strategy and Tactics in Antibacterial Chemotherapy by Robert Knox; (4) Microbial Resistance to Harsh and Destructive Environmental Conditions by D. J. Kushner; (5) Antibacterial Chemotherapy with Sulfonamides by Lucien Neipp; (6) Experimental Pharmacology and Toxicology of Sulfonamides by R. E.

Bagdon ; (7) The Nitrofurans—Chemotherapeutic Properties by Henry E. Paul and Mary F. Paul ; (8) Antibacterial Agents of Limited Action by R. J. Schnitzer ; (9) Experimental Chemotherapy of Tuberculosis and Other Mycobacterial Infections by Guy P. Youmans and Anne S. Youmans ; (10) Experimental Chemotherapy of Leprosy by Philip C. Eisman.

C. V. R.

**Self-smoothing Fabrics.** By J. T. Marsh. (Chapman & Hall Ltd., London, W.C.-2), 1962. Pp. vi + 399. Price 70 sh.

Until the publication of this book a Textile Chemist had no book to give all the information on Resin finishing. The book has a unique place in the field as it is written with the authority of many years of actual experience by one of the inventors of the original chemical process. Though the book is meant for a Textile Chemist with a specialised knowledge on resin finishing, this will be equally useful to a student as well as the Finisher.

The twenty-three chapters divided under the sub-groups 'The substrata', 'Chemical compounds', 'The finishing process', 'The Mechanism of Deformation and recovery' and 'Testing' are well illustrated and documented. The chapter on 'chemical compounds' is very informative and deals with all types of thermosetting resins, linear reactants, cyclic reactants, chloralkyl compounds, catalysts additives.

The theory of crease recovery and also the testing methods are dealt with in great detail.

By the publication of this book Marsh had added one more book to his series of 'Textile Science', 'Bleaching', 'Finishing', 'Mercerising' and 'Chemistry of Cellulose' all of which are written in a lucid manner to suit students, technologists and chemists alike.

C. V. R.

**Energy Band Theory** (Volume 16 of Pure and Applied Physics). By Joseph Callaway. Consulting editor H. S. W. Massey. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. 357. Price \$ 10.00.

This book contains a discussion of the principles and methods of the calculation of the energy levels of electrons in crystals. In Chapter 1, the language of band theory is developed with attention to the general features of band structures which may be deduced from considerations of crystal symmetry. Chapter 2 includes a description of the principal methods for the solution of the Schrodinger equation in

a periodic potential together with a survey of the problems encountered in the construction of the potential function in the Hartree-Fock approximation. Some of the results of experimental investigations of the band structures of materials, including the alkali metals, the noble metals, and common semiconductors, are surveyed in Chapter 3, and compared with theoretical calculations. The effects of external perturbations including electric and magnetic fields, on band structures, are considered in Chapter 4, together with a discussion of the energy of electrons bound to point impurities. A calculation of optical constants is also included.

C. V. R.

**Holden-Day Series in Mathematics:** (Holden-Day, Inc., 728, Montgomery Street, San Francisco):

**Elementary Analysis.** By R. F. McCoart, M. W. Oliphant and A. E. Scheerer, 1964. Pp. 251. Price \$ 7.95.

**Elements of General Topology.** By S-T. Hu, 1964. Pp. 214. Price \$ 8.75.

**Challenging Mathematical Problems.** By A. M. Yaglom and I. M. Yaglom, 1964. Pp. 231. Price \$ 5.95.

The first two are introductory text-books written for use in American Colleges for liberal arts students as well as first-year graduate students in mathematics. *Elementary Analysis* provides a logical approach to basic concepts of calculus, limiting the choice of material to selected topics. The emphasis is on functions of one variable, their limits, their derivatives and their integrals. There are large number of exercises for students to prove.

Topology has not yet come to be included in the graduate curricula of all Indian Universities. For those who would like to be introduced into the subject Hu's book can be recommended. There are six chapters in the book. The first three chapters cover the elements of general topology under the headings: Sets and functions; Spaces and maps; Properties of spaces and maps. The last three chapters present some specific topological topics under the heads: Polytopes; Spaces and maps; and Fundamental groups.

Students of mathematics in Indian Universities can profitably read these two volumes to get an idea of the scope of syllabus in the subject learned by their compeers in the antipodes.

The third book written by twin brothers is a translation and adaptation (by J. McCawley, Jr.

and B. Gordon) of a well-known Russian problem book. As the title indicates, the volume contains a hundred challenging problems and their solutions. The chief aim in this book of problems is to acquaint the reader with a variety of new mathematical facts, ideas and methods. The reading is not only amusing but very stimulating.

A. S. G.

**Elementary Particles and Cosmic Rays.** By Alladi Ramakrishnan. (Pergamon Press), 1962. Pp. xiii + 558. Price £5 net.

This book covers two distinct areas of physics; Part I deals with Elementary Particles and Part II with Cosmic Rays.

Elementary particle physics has been covered in a comprehensive manner: single particle wave functions and wave equations, quantum electrodynamics, quantum field theory and the non-perturbative approach, pions and strange particles, weak interactions, strong interactions and symmetries. There are extensive, readily available formulæ, and an excellent collection of references. This could be recommended as good first reading for all those embarking on theoretical physics and intending to carry out research on elementary particles. The trouble with this field is the rapid rate at which new information comes in: resonance physics, weak interactions, Regge pole theory, scattering processes, etc.

Part II dealing with Cosmic Rays is not in the same class. The treatment and choice of topics is rather conservative: primary cosmic radiation, time variations, geomagnetic effects, interactions, cascades and origin. This would have been perfectly satisfactory many years earlier. The IGY and space exploration, the discovery of the many solar-terrestrial relationships, radiation belts, solar particle radiation, the massive attack on extensive air showers, deep underground studies, recent International Cosmic Ray Conferences which may be referred to in Proceedings of recent International Cosmic Ray Conferences (Moscow 1959, Kyoto 1961), and which have had a profound impact on the outlook of cosmic ray research are left out. No feeling of this exciting perspective, as exciting as the ferment in elementary particle physics, is conveyed by Part II. This is a pity. This may be because the author's deep personal interests lie in the areas covered by Part I; of the areas covered by Part II, that field to which the author has made personal contributions, namely, the mathematical theory of cascades, is well presented. Having said this, in fairness, it should be stated

that the topics chosen for coverage in Part II have been dealt with reasonably satisfactorily.

The reviewer's personal view is that the two parts should have been covered in separate volumes. There seems to be no advantage in binding into one volume the two completely separate entities; there is so little cross-referencing. Cosmic ray research today links up largely with astrophysics, cosmology, magnetohydrodynamics, plasma physics and geophysics. It is only in the studies of interactions at energies unattainable with machines that cosmic ray research logically ties in with Part I; and even then the language of the cosmic ray physicist studying this area, because of the very nature of the observations and limited experimental techniques, is so different from that used in Part I. There is today a distinct need for a good monograph on cosmic ray physics but Part II unfortunately does not fill that role.

The production standards are high, as is expected of Pergamon Press; but the cost is also rather high and puts it beyond the reach of most students, a group for whom it has been written. There are some unfortunate mistakes such as the one on page 397 where, in the famous Bethe-Bloch ionization loss formula, the denominator contains  $v^3$  instead of  $v^2$ .

M. G. K. MENON.

**Advances in Protein Chemistry (Vol. 17).**

Edited by C. B. Anfinsen, M. L. Anson, K. Bailey and J. T. Edsall. (Academic Press, New York and London), 1963. Pp. xiv + 412. Price \$14.00.

This volume of this well-known series starts with a personal tribute to the late Professor W. T. Astbury, a pioneer in the study of the molecular structure of proteins. The aim in this tribute is primarily to portray Astbury as a man; his scientific work is too well known to require repetition.

The volume consists of six reviews on diverse fields. The chapter on "The Properties of Proteins in Non-Aqueous Solvents" by S. J. Singer deals with some of the various new developments and is in a sense in the nature of a preview. Hydrogen ion titration curves are dealt with in the next chapter by C. Tanford, who is a leader in this field in recent years. The next chapter on "Regularities in the Primary Structure of Proteins" by F. Sorm and B. Keil is more controversial and deals more with the authors' point of view, which may not be generally accepted. However, the data

pointed out are sure to lead to interesting investigations. This is followed by a short chapter on the use of "Cross-linked Dextrans as Molecular Sieves" by J. Porath. The next chapter on elastin by S. M. Partridge is extensive and informative, and is in fact the first such review on this protein. Although collagen has been extensively studied, elastin has been relatively neglected, and it is reassuring to note that so much interesting work has been done and going on on it. The last chapter by D. B. Wetlaufer deals with the ultra-violet spectra of proteins and amino-acids, particularly on the more recent developments.

All the chapters are uniformly well written and there is no doubt that this volume of the *Advances* will be widely read by chemists and biochemists alike.

G. N. R.

**Progress in Astronautics and Aeronautics** (Vol. 12). *Ionization in High Temperature Gases*. Edited by K. E. Shuler and J. B. Fenn. (Academic Press, New York), 1964. Pp. xiv + 409. Price: Reg., \$5.75; Members, \$4.25.

This is the latest volume in a series started by what used to be the American Rocket Society, and now being continued by its successor, the American Institute of Aeronautics and Astronautics. The present volume is a selection of papers presented at an ARS Conference on Ions in Flames and Rocket Exhausts, held in October 1962, but it contains in addition a few invited survey articles.

The title of the Conference describes the contents of the book fairly well. In a gas in equilibrium, the ionization present can always be computed under any given conditions by Saha's equation. In practice, however, there are two questions: first, one is interested very much in the rate at which ionization occurs, which is crucial in a dynamic situation; second, the problem becomes very complicated because of the large number of possible, competing reactions. Most papers in the book are concerned with aspects of these two questions. About half of it is the work of chemists, who give an interesting summary of their work on the physical chemistry of ionization, and report with satisfaction that the kind of ionization processes that actually occur, especially in flames, are now basically understood. In fact it is knowledge of the ordinary chemical reactions involving neutral molecules that is now the weaker link, for here there are no experimental techniques yet comparable to those so effectively used on charged particles.

The rest of the book is perhaps inspired more directly by applications. Apparently nobody is happy with the ionization actually obtained, for while one group is busy trying to suppress it, other groups are doing their best to enhance it! For those interested in magnetohydrodynamic effects and devices, a high electrical conductivity is important. Four papers deal with this question, and there is now much information on the possibilities and limitations of seeding. There is one paper on rocket exhausts, where ionization is undesirable because it affects communications and detection. There are two papers on ionization behind shocks and detonations, including a useful summary by Teare of the work done over the years at AVCO.

It would have been interesting to be told how all this gas physics is coupled with the fluid dynamics, especially in rocket exhausts, but presumably that was not quite within the scope of the Conference. In any case, the volume is a timely, useful and authoritative survey of its subject.

R. NARASIMHA.

#### Books Received

*Developments in Applied Spectroscopy* (Vol. 3).

Edited by J. E. Forrette and E. Lanterman. (Plenum Press, 227 W. 17th Street, New York; N.Y. 10011), 1964. Pp. ix + 409. Price \$17.50.

*Functions of a Complex Variable and Some of Their Applications* (Vol. 1). By B. A. Fuchs and B. V. Shabat. (Addison-Wesley Pub. Co., Reading, Mass., U.S.A.), 1964. Pp. xvi + 431. Price \$10.00.

*Optical Activity and Chemical Constitution*. By B. K. Singh and O. N. Perti. (Asia Publishing House, Bombay-1), 1963. Pp. xii + 149. Price Rs. 9-00.

*Handbook of the Madras Government Museum*. Edited by S. T. Satyamurti. (The Superintendent, Government Museum, Madras), 1964. Pp. 154. Price Rs. 5-40.

*Analytical Methods for Pesticides, Plant Growth Regulators and Food Additives*. Edited by G. Zweig. Vol. 2: *Insecticides*. Pp. xvii + 619. Price: Reg. \$23.00, Sub. \$20.00; Vol. 3: *Fungicides, Nematocides, Soil Fumigants, Rodenticides and Food and Feed Additives*. Pp. xii + 237. Price: Reg. \$12.00, Sub. \$10.00.

*Verhaltensfors Chung*. By G. Tembrock. (VeB Gustav, Fischer Verlag, Jena), 1964. Pp. 521. Geb. D.M. 50.30.

*Annual Review of Biochemistry* (Vol. 33). (Annual Reviews, Inc., 231, Grant Avenue; Palo Alto, California, U.S.A.), 1964. Pp. vii + 855. Price \$9.00.

[illegible]Inlet Pumping Radiation at 1.0  $\mu$ 

According to the description of the existing Research Development, we did the corresponding design that could be used to design the intelligent fault diagnosis of the internal gear pump. The main steps of the design are as follows: (1) determining the main effects of the design; (2) determining that existing design; (3) determining the source. The design development steps are reported in the following.

Long wavelength light is scattered by small particles and molecules in the medium. This light may play a significant role in the absorption of millimeter wave radiation.

On 14 new laser diodes were collected in a pure neon discharge. Four have wavelengths longer than 1000 nm and are referred to here. The new laser diodes have a structure like a meter long and 4 mm in diameter. Mirror at both ends are coated with vacuum deposited silver. The IR's laser beam is emitted from the cavity through a 2 mm aperture at the centre of one of the mirrors (cf. Fig. 1a). (1964, 278, 159)

Rare Earth Garnets as Solid State Optical  
Media.

New techniques in growing large aluminum garnet crystals have made possible a solid-state optical maser which can operate continuously at room temperature using a long life tungsten lamp as the pumping source. This is a major step in putting solid-state optical masers on an equal footing with gas optical masers as far as continuous operation is concerned.

The newly developed garnets on which laser studies have been reported are yttrium aluminum, yttrium gallium and gadolinium gallium garnets, which are grown from a molten salt flux. They are chemically stable, hard and can be doped with any of the rare earth elements. The crystals are not damaged by the pumping

shape, although in general these may be classified as subspherical.

radiation which can be easily polished. When neodymium is introduced in the garnet crystal, an especially narrow line fluorescent emission is observed and the neodymium absorption lines are well suited to the light spectrum produced by a laser at a longer rate to have a long life. These properties permit the considerably reduced threshold required for continuous operation at room temperatures.

The key to growing large crystals from a molten melt is the addition of a small amount of boron oxide to bear oxyfluoride flux. The boron oxide limits crystal nucleation. Flux entrapped in the crystals is eliminated by adding a large quantity of aluminium oxide to the melt. As the melt slowly cools from 1300° C. aluminium oxide crystals are the first to form. The cap of aluminium oxide prevents the flux from volatilising and provides a preferred nucleating surface for the garnets. (J. Frank, *Ibid.*, 1964, 278, 156)

#### Interferometric Raman Spectroscopy Using Infra Red Excitation

Many pure substances and industrial intermediates are strongly coloured and their Raman spectra cannot be recorded using ultra-violet and visible lines, but nearly all compounds have a region of transparency in the near infra-red. If, therefore, methods could be developed in which a selection of infra-red exciting lines were used Raman spectroscopy could be more widely applied and could become a valuable complement to standard infra red analysis.

The basic difficulty comes from the fact that as the wavelength of the exciting line is increased, the scattered intensity falls off rapidly. It is therefore important to seek a spectroscopic technique which makes best use of the reduced amount of scattered radiation, and in this respect the virtues of the Michelson interferometer plus Fourier transform method are now well known.

The first results of the researches in the Basic Physics Division of the National Physical Laboratory, Teddington, aimed at extending the usefulness of Raman Spectroscopy by developing methods of infra-red excitation are reported in an article in *Nature* (September 5, 1964). The technique uses the gallium arsenide injection laser as the source. It has the great advantage

that in any experiment requiring the elimination of the exciting line from the scattered radiation, a gallium arsenide filter may be placed in front of the I.R. photomultiplier. Gallium arsenide has a very steep absorption edge the wavelength of which can be changed by varying the temperature. Thus the filter can be set to attenuate strongly the exciting line and transmit any Raman line of longer wavelength that may be present.

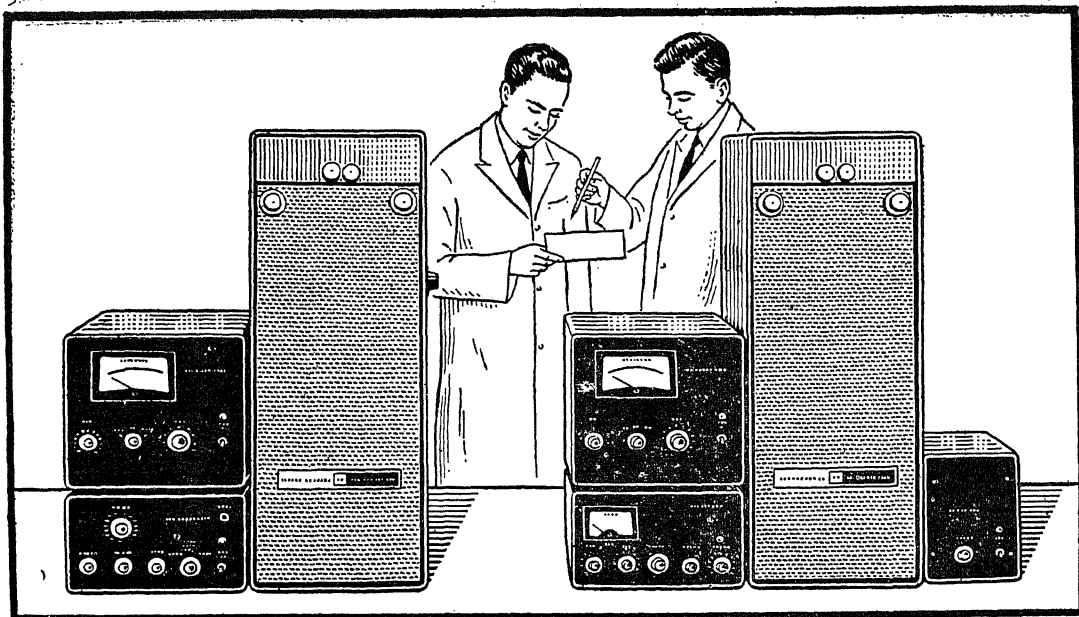
Results of observations on iodine dissolved in carbon tetrachloride, and on dilute solutions of cyanine dye demonstrate the possibilities of Raman measurements with near infra-red exciting lines.—(*Nature*, 1964, 203, 1052.)

#### Spiral Structure in the Andromeda Nebula

The Great Nebula in Andromeda has played an important part in the development of our knowledge of galaxies. The late Dr. Walter Baade initiated many investigations of the Nebula which are now being completed by his colleagues. Two papers just published in the *Astrophysical Journal* (1964, 139, 1027 and 1045) deal with the emission nebulae in the Nebula. At one time it had been thought that no gaseous emission nebulae were present in the Andromeda Nebula. Baade doubted this, and accordingly photographed the Nebula with the 100-in. telescope at Mount Wilson, using various specially selected combinations of photographic plates and filters. The first paper by Baade and Arp catalogues 688 emission nebulae. These objects appear to outline the spiral structure well but their interpretation is not easy. In the second paper Arp gives a detailed discussion of the problem of the structure of the Nebula.

Direct photographs have shown that the best representation of the spiral structure is obtained if it is assumed that the Nebula is tilted at an angle of 16° to the line of sight. But on this picture it becomes difficult to fit in the emission nebulae. Dr. Arp suggests that the whole plane of the Nebula is warped, with a tilt of 16° for the side more distant from us, and for the central regions, and a tilt of 11° for the near-side regions. On this picture the emission nebulae form a complete spiral. There is evidence that the warping is caused by the companion elliptical galaxy, M 32.—(*Astrophys. J.*, 1964, 139, 1027.)

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# THE NEW PHYSIOLOGY OF VISION

## Chapter V. Corpuscles of Light and the Perception of Colour

SIR C. V. RAMAN

**T**HE subject of colour is of extraordinary interest and importance. The nature of the colour-sensations experienced in various circumstances and the genesis of those sensations are, therefore, amongst the major problems with which the physiology of vision is confronted. In the present chapter these problems will be considered, but we shall restrict ourselves to the specially simple class of cases in which the sensations are those excited by light of spectral purity, in other words, by radiations limited to a narrow range of wavelengths in the spectrum. The sensations excited by spectrally composite radiations present a field of enquiry of a more complex nature. They will be dealt with in later chapters.

That the sensation of colour arises from and is closely related to the corpuscular nature of light is evident from the progression of colour observed in the spectrum. When white light emitted by a solid body held at a high temperature is analysed by passage through some dispersing apparatus, e.g., a prism or a diffraction grating, it appears spread out into a continuous band of colour. If the dispersion is adequate, a great many different colours may be distinguished in it. These colours form a continuous sequence, and since the light isolated from a sufficiently narrow region of the spectrum consists of corpuscles all having the same or nearly the same energy, it follows that each specific colour observed in the spectrum corresponds to a distinct set of corpuscles all having the same or nearly the same energy. The association thereby made evident between the energy of the light-corpuscles and the colour sensations excited by them is clearly of a fundamental nature. It has, of necessity, to form the basis of any attempt to ascertain or elucidate the nature of the sensations of colour.

*Luminosity and Colour.*—The visual effect of light reaching the eye is determined by two variables capable of quantitative specification and measurement, viz., the flux of light and its spectral character. We may proceed to associate these two physical variables respectively with the two characters which are noticeable in our visual sensations, viz., the brightness of the

light and its chromatic effect. This way of regarding the matter is, however, not free from difficulties. It assumes without proof that luminosity and colour are independent sensations. Actually, it is possible to take a different view of the situation. While recognising that the visual effect of light is determined by two factors which can be independently varied, we may regard the sensation as being itself one and indivisible. An argument which lends support to this latter view may be based on a consideration of the effect of progressively reducing the flux of light till it reaches the vanishing point, while its spectral character remains unaltered. It is evident that the entire sensation would disappear when the flux of light is zero. This leads us to the inference that luminosity and colour are not independent sensations but are only aspects of one and the same sensation. That we can recognise a difference in brightness and/or a chromatic difference between two sources of light set side by side for comparison is a fact of observation. It shows that the visual effect of light presents certain recognisable characters. But it does not demonstrate that these characters are independent of each other, in other words, that they can be varied without mutually influencing each other.

By the use of appropriate equipment, the radiations appearing as individual lines in the spectra of metallic vapours may be isolated and the visual sensations excited by such light at various levels of intensity may be studied. What has been stated above makes it clear that we would not be justified in assuming that an alteration of the light-flux in such cases would result in altering the observed luminosity but would leave the chromatic sensation unaffected. So far from this being the case, the investigations presently to be described show that the chromatic sensations excited by such spectrally isolated radiations are profoundly modified by variations of the light-flux. The factual situation thus revealed is clearly of fundamental significance in its physiological implications.

*Observations with the Sodium Lamp.*—In the spectrum of the light emitted by sodium vapour

in the commercially available lamps, the yellow lines are so enormously more powerful than the other radiations present that the latter can be ignored. The sodium vapour lamp is thus a very convenient tool for a study of chromatic sensations at various levels of illumination. The lamp is enclosed in a box, and an aperture on one side of it allows the light to emerge and pass through a diffusing screen of ground glass followed by an iris-diaphragm. The opening of the iris can be varied from a diameter of ten centimetres down to a few millimetres. The observations are made in a fairly large room (ten metres square) which can be completely darkened.

A chromatic sensation being a matter of subjective perception, it is essential to provide a means of ensuring that the experiences reported are not of an illusory nature. The following procedure has accordingly been adopted in the investigation. The lamp and the observer are located near each other at one end of the room, both facing towards its further end. A plastic screen of perfectly white material is set up on a stand facing the lamp and the observer so that the light issuing from the lamp falls on the screen. The surface of the screen is smooth and has a good polish. It accordingly reflects a part of the light falling on it and a reflected image of the source of light is seen by the observer. This exhibits a brilliant orange-yellow colour. Neither the brightness of this reflected image nor its colour shows any alteration when the iris-diaphragm is closed down from the full aperture of ten centimetres down to a few millimetres. Likewise, neither the brightness of the reflected image nor its colour shows any alteration when the screen is moved away from its original position close to the lamp and the observer to the further end of the room.

But the part of the light falling on the screen which enters the plastic material and is diffused backwards, thereby becoming visible to the observer as a general illumination of the screen, behaves quite differently. The strength of this illumination varies enormously with the circumstances. When the iris is fully open and the screen is close to the source of light, it is quite high. As the screen is moved away from the lamp and the observer, the illumination diminishes rapidly. If, further, the iris is also progressively closed down, the illumination of the screen becomes extremely feeble. In the various circumstances stated, the observer can compare

the colour of the reflected image of the source with the colour of the diffuse illumination of the screen. It then becomes evident that the alterations in the brightness of the diffuse light go hand in hand with changes in the chromatic sensation excited by it. As the brightness falls, the chromaticity diminishes and the diffuse illumination becomes more nearly achromatic. Even when the light diffused by the screen is at its maximum intensity, its colour does not approach in its quality, the rich orange-yellow of the original source. In the final stages, when the illumination of the screen is very weak, the chromaticity persists but is then only barely perceptible.

An alternative procedure which enables the observer to convince himself of the reality of the changes in chromaticity resulting from changes in luminosity is to view an illuminated white card held at arm's length and rapidly to alter the strength of its illumination by the sodium light. This may be done, for instance, by quickly reducing the aperture of the iris-diaphragm. Alternatively, with an iris opening of about one centimetre, the card may be held near the source and then moved away quickly to a greater distance. The reductions in chromaticity thus brought about are strikingly obvious.

*Observations with the Mercury Lamp.*—Using a double monochromator and the arrangements already described in an earlier chapter, each of the stronger radiations of the mercury arc may be isolated and utilized for observations of the same nature as those detailed above. With the instrument set to pass the light of any selected radiation in the spectrum, the exit-slit of the monochromator when viewed directly from any position by the observer exhibits the colour of the particular radiation quite brilliantly. On the other hand, if the light diverging from the exit-slit falls upon a white card or a white plastic screen and the light diffused by it is viewed by the observer, the colour observed is relatively very weak. Indeed, only when the diffusing screen is held very close to the exit-slit is the colour of the diffused light at all comparable with the colour of the light from the slit as viewed directly. The weakening of the colour is thus evident even when the illumination of the screen is still fairly strong. As the screen is moved further and further away from the slit and the illumination becomes weaker by reason of the divergence of the emerging beam, the chromaticity continues to

diminish continuously and progressively and the perceived sensation approaches more and more nearly to an achromatic sensation. Nevertheless, the chromaticity continues to be detectable so long as the illumination of the screen can itself be perceived.

It should here be emphasised that though effects of the nature described can be observed with every one of the radiations spectrally isolated from the light of the arc, the rapidity of the chromatic change noticed when the diffusing screen is moved away from the exit-slit is by no means the same for all of them. The most striking and rapid changes are exhibited by the  $\lambda$  4358 radiation of the arc appearing in the blue region of the spectrum. Very striking also, though not so rapid, are the changes noticeable with the  $\lambda$  6150 radiations in the red region of the spectrum. On the other hand, with the  $\lambda$  5461 radiations in the green and the  $\lambda$  5770-5790 radiations in the yellow, we have to move the receiving screen much further away from the exit-slit before the chromatic changes are as obvious as with the blue and red radiations. These differences may, at least in part, be explained in terms of the greater visual intensity of the  $\lambda$  5461 and  $\lambda$  5770-5790 radiations of the mercury arc as compared with the  $\lambda$  4358 and the  $\lambda$  6150 radiations.

*The Significance of the Results.*—The highly remarkable but indisputable fact which emerges from the studies which have been described is that the chromatic sensations usually known as the colours of the spectrum fade away and progressively tend towards an achromatic sensation (though they do not actually become such) as the illumination which reaches the observer is continuously reduced. It is evident that we have here an effect of fundamental significance in the physiology of vision. The question may here be asked whether such a striking phenomenon could not be demonstrated in a simple fashion, as for example, by an observer viewing directly the spectrum of a light-source the luminosity of which is progressively diminished. The answer is that the subjective nature of the effect makes it desirable that the arrangements

for its observation should be such as to exclude all possibility of error and ensure the reality of the findings reported.

We now turn to the basic question, why should the chromatic sensation excited by spectrally pure radiation fade away as the effective light-flux is diminished? The answer to this may be found in the two preceding chapters in which the perception of luminosity and the perception of form were respectively discussed. In both of those chapters, we were concerned with effects in which the corpuscular nature of light comes visibly into evidence. In both cases also the effects observed become increasingly more conspicuous as the light-flux is diminished; in both cases also, they depend notably on the spectral character of the illumination. The parallelism in these respects between the effects described in those chapters and those now under consideration is evident. It is quite appropriate therefore that we proceed to find an explanation on generally similar lines.

What the observations indicate is that the chromatic sensations which we normally associate with the different regions in the spectrum demand that the corpuscles of light reach the individual visual receptors in the retina in sufficient numbers and follow each other in such rapid succession as to give rise to a continuous and coherent sensation. These are precisely the conditions in which the fluctuations of luminosity in the field under observation would cease to be noticeable and in which the visual acuity as determined by appropriate tests would reach the optimum value. That the chromaticity is also at its best in these circumstances is readily verifiable by observation. It is found when the illumination is sufficient to meet the most stringent tests for visual acuity, the colour perceived is most brilliant. *Vice-versa*, when the illumination falls and the visual acuity is reduced thereby, the chromatic sensation is noticeably weakened. As the chromatic sensation progressively becomes weaker and weaker by reason of the diminishing light-flux, the visual acuity also suffers and touches very low levels.

## SOME SPECIAL FEATURES IN THE STUDY OF LEUCOANTHOCYANIDINS IN FRUITS

R. N. KHANNA, V. KRISHNAMOORTHY, A. S. KUKLA AND T. R. SESHADRI

*Department of Chemistry, University of Delhi, Delhi-6*

**L**EUCOANTHOCYANIDINS form an important group of naturally occurring plant products and are known to be present in almost all parts of plants. Considerable attention has been paid in recent years to the relationship between leucoanthocyanidins and tannins and it is now recognised that under suitable conditions the monomeric flavan-3, 4-diols polymerize<sup>1</sup> to dimers and polymers and the latter two categories are grouped as tannins.<sup>2</sup> Astringency in fruits has been attributed to the presence of these leucoanthocyanidins (mostly dimers)<sup>3</sup> and it is believed that they affect the cross-linking of proteins and glycoproteins in the mouth and thus reduce the lubricant action and give the sensation of astringency.

In fruits, the monomeric leucoanthocyanidins are invariably accompanied by polymeric leucoanthocyanidins (tannins) in which the leucoanthocyanidin units are probably linked together in repeating units capable of depolymerisation to yield anthocyanidins with hot acids.<sup>4</sup> Since the only means of detecting and characterizing leucoanthocyanidins in plants is by their ability to yield anthocyanidins, the study of these compounds by this method is complicated. A systematic study thus involves the initial separation of the various polymers by the usual methods of chromatography and solvent separation followed by conversion into anthocyanidins. During the course of our investigations on leucoanthocyanidins in fruits we have made some significant observations as described below.

### I. PAPER CHROMATOGRAPHY

Circular and two-dimensional chromatography has been frequently employed for the study of leucoanthocyanidins in plant materials. Among the various reagents<sup>5-7</sup> used as developers for these chromatograms, *p*-toluene sulphonic acid<sup>6</sup> has been considered to be specific for the detection of flavan-3, 4-diol and flavan-3-ol systems. When paper chromatograms of these systems are sprayed with a 5% solution of *p*-toluene sulphonic acid in absolute alcohol and then kept at 75–80° for 20 minutes, spots of various colours<sup>8,9</sup> ranging from dark-brown, brown-pink, pink, and scarlet are reported to be produced depending upon the molecular size and the complexity of the flavonoid system. Dihydroflavonols<sup>9</sup> are known to give yellow fluorescent spots visible in

ultra-violet light while catechins develop spots which are dull yellow<sup>8</sup> or brown<sup>9</sup> in visible light and deep blue-mauve in ultra-violet light. This reagent has therefore been used in paper chromatography as suitable not only for detection of flavonoids but also for distinguishing between various categories.

During the course of our investigation on the leucoanthocyanidins present in fruits it has been observed that *p*-toluene sulphonic acid reagent developed grey, brown and pink spots with fruit extracts. In order to get an idea of the reaction of this reagent on components other than leucoanthocyanidins occurring in these juices, known samples of sugars, nitrogenous and non-nitrogenous acids have been examined and the results are given in Table I. Maltose, galactose,

TABLE I

Sample	Colour (visible)	Colour (ultra-violet light)
Sucrose ..	Brown	Reddish-brown
Fructose ..	do.	do.
Sorbose ..	do.	do.
Tyrosine ..	Pale brown	Pink
Asparagine ..	Yellow (hot)	Light violet
Aspartic acid ..	No colour	Violet
Ascorbic acid ..	Light brown	Light brown

glucose, arabinose, glutamic acid, tartaric acid and citric acid do not develop any colours under the above conditions.

From the above data it is clear that besides flavonoids, ketoses, sucrose, ascorbic acid and even amino-acids respond to this test. The coloured spots produced by these compounds are prominent and might even superimpose the spots produced by leucoanthocyanidins. Since in edible fruits, the leucoanthocyanidins are always accompanied by sugars and many other compounds mentioned in Table I, the use of *p*-toluenesulphonic acid reagent for the detection of leucoanthocyanidins and related products could only be made with reservations.

### II. CONVERSION OF LEUCOANTHOCYANIDINS INTO ANTHOCYANIDINS

As already mentioned, the method for the detection and identification of leucoanthocyanidins in plants is to convert them into the corresponding anthocyanidins by heating in acid solutions. During our investigations on the scope of this reaction, we have met with unexpected results. The juices of apples

(*Pyrus malus*) and wild unripe pomegranates (*Punica granatum*) seemed to contain leucoanthocyanidins. By heating with acid for a short period the deep colour of anthocyanidins can be obtained and by careful extraction the identification could be effected. But on continued refluxing with alcoholic hydrochloric acid (1 hr.) as is usually done, these juices yielded black solutions and some black precipitate also and no anthocyanidins could be isolated. Looking for the reason, these fruit juices were found to contain good amounts of fructose, glucose and/or sucrose. Consequently, the stability of anthocyanidins in the presence of these sugars was examined. It was observed that fructose, sorbose and sucrose on heating with alcoholic hydrochloric acid gave brown to black solutions. When this reaction was repeated in presence of cyanidin chloride similar coloured solutions were obtained which were devoid of anthocyanidin. Even when the solutions were kept at room temperature, without heating, the anthocyanidin chromophore was lost after two days (see Table II). Parallel results

the anthocyanin to sugar and aglycone, (b) transformation of the aglycone to colourless pseudo-base and (c) destruction of the pseudo-base by molecular oxygen. However, the mechanism involved in the decolourisation of anthocyanins by light is not very clear.

The above observations may throw some light on the process of browning in fruits. Ketoses are known to be responsible for browning by their decomposition. Their effect on anthocyanidins (which might arise from leucoanthocyanidins) may provide additional cause for the browning of fruits. The above observation may have interest in another connection. It has been suggested that there is loss of astringency in fruits during ripening probably due to increased polymerisation of leucoanthocyanidins and the higher polymers contributing little to astringency.<sup>3</sup> While that may be true, there is also the possibility of keto-sugars removing leucoanthocyanidins after they are converted into the anthocyanidin stage.

We thank the U.S. Department of Agriculture for financial assistance.

TABLE II

Anthocyanidins (in ethanolic hydrochloric acid) + fructose + 2-3 drops of hydrochloric acid (total volume about 10 c.c.) were kept for two days at room temperature and the spectra were recorded on a Hilger spectrophotometer.

No.	Anthocyanidin	$\lambda_{\max}$ in $\mu$	
		Before treatment	After treatment (strong)
1	Luteolinidin chloride	503	280, 500 (strong)
2	Cyanidin chloride	545	275, 450 (infl.)
3	Delphinidin chloride	555	280
4	5, 7-Dimethoxy-3-hydroxy flavylum chloride	400, 480	280, 470 (weak)
5	5, 7, 4'-Trimethoxy-3-hydroxy flavylum chloride	420, 510	280
6	7, 3', 4'-Trimethoxy-3-hydroxy flavylum chloride	400, 510	280
7	5, 7, 3', 4'-Tetramethoxy-3-hydroxy flavylum chloride	523	280, 460 (weak)
8	7, 3', 4', 5'-Tetramethoxy-3-hydroxy flavylum chloride	470	280
9	Fructose + hydrochloric acid (Blank)		280

were obtained with sorbose and sucrose but glucose under the same conditions had no effect.

The above spectral data indicate that except luteolinidin chloride (wherein there is no 3-hydroxyl) other anthocyanidins were decomposed. What actually happens is not clear; they may be converted into other coloured products or be decolourised. It would appear that the hydroxyl group at position 3 has an important part in the above reaction and the hydroxyls at other positions have no effect. It has also been observed that cyanin, in which the 3-hydroxyl is blocked by glycosylation is stable under these conditions. Earlier studies have shown that decolourisation of anthocyanins can be brought about by means of enzymes<sup>10</sup> or light.<sup>11</sup> The decolourisation by enzymes involves<sup>10</sup> (a) enzymatic hydrolysis of

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# CHANGES IN THE MERIDIONAL CIRCULATION OVER INDIA ACCOMPANYING THE ONSET AND WITHDRAWAL OF THE SOUTH-WEST MONSOON

R. ANANTHAKRISHNAN, A. R. RAMAKRISHNAN AND M. MARY SELVAN  
India Meteorological Department, Poona

## 1. INTRODUCTION

IN a recent article in this journal<sup>1</sup> the changes in the zonal circulation over India accompanying the onset and withdrawal of the south-west monsoon during 1963 were briefly presented. The corresponding features in respect of the meridional circulation will be discussed in the present note.

1.2. Although the meridional circulation is in general weaker than the zonal circulation, it is a very important link in the general circulation of the atmosphere. The general circulation arises from the fact that for the earth-atmosphere system the incoming radiation exceeds the outgoing radiation in the lower latitudes while the reverse condition obtains at the higher latitudes. This necessitates a flow of heat from lower towards higher latitudes which is accomplished by the meridional circulation. The salient feature of the zonal component of the general circulation is the persistence of westerly winds in middle latitudes and easterlies in equatorial latitudes. From considerations of angular momentum the maintenance of this type of zonal flow also demands a meridional circulation. The zonal and meridional circulations are subject to seasonal and local variations arising from the apparent oscillation of the sun between the Tropic of Cancer and the Tropic of Capricorn and land-sea contrasts. The latter are particularly dominant over the eastern half of the northern hemisphere.

## 2. MONTHLY MEAN MERIDIONAL WINDS

Figure 1 gives isopleths of monthly mean meridional winds over Trivandrum, Madras, Nagpur and New Delhi during 1963. The areas of northerly and southerly winds are clearly demarcated in the diagram. It will be seen from Fig. 1 that during the monsoon season the meridional flow in the entire troposphere over Trivandrum, Madras and Nagpur is predominantly northerly. Over Delhi, while the flow continues to be northerly up to about 8 km, southerlies are noticed above this level.

## 3. DAY-TO-DAY CHANGES IN MERIDIONAL CIRCULATION

Isopleths of daily meridional winds for the four stations are shown in Figs. 2-5. The periods covered are the same as those for the zonal winds discussed in the earlier note.

(a) *Trivandrum*.—Barring the lowest 1 to 2 km,

where local influences affecting the circulation are most pronounced, the chief feature of the meridional flow in April is the predominance of northerlies in the lower troposphere and fairly strong southerlies aloft. By the end of April the northerly regime gains predominance at all levels up to 20 km. From a comparison with Fig. 1 of the previous note on zonal flow it will be seen that this epoch also coincides with that of the contraction and weakening of the westerly flow in the middle and upper troposphere. The onset of the monsoon at the end of May is not accompanied by any significant change in the pattern of meridional flow. Throughout the period from May to August the meridional flow is predominantly northerly interspersed with spells of southerlies in depth and the duration of the southerly spells show wide variations. Beginning from the end of August southerlies interspersed with spells of northerlies gain predominance above 4 km.

(b) *Madras*.—The main features of the meridional flow over Madras are nearly the same as those for Trivandrum. It will, however, be seen from the diagram that from the end of August the southerlies of the upper troposphere are more steady and the spells of northerlies less frequent over Madras as compared with Trivandrum.

(c) *Nagpur*.—From the beginning of April till about the middle of May alternate spells of northerlies and southerlies occur, with the southerlies exceeding 40 knots in the upper troposphere. Thereafter, northerlies gain sway throughout the troposphere. By about the middle of August the northerly regime begins to give way to southerly in the upper troposphere.

(d) *New Delhi*.—Up to the middle of May the broad features of the meridional flow over Delhi are similar to those over Nagpur. Thereafter till the end of September alternate spells of northerly and southerly spells occur. Here the northerlies are more persistent in the lower troposphere and southerlies in the upper troposphere and lower stratosphere.

## 4. CONCLUSIONS

This study brings out the following conclusions:

- (i) The meridional circulation is in general weaker but also susceptible to larger fluctuations than the zonal circulation.

MONTHLY MEAN MERIDIONAL WINDS - 1963

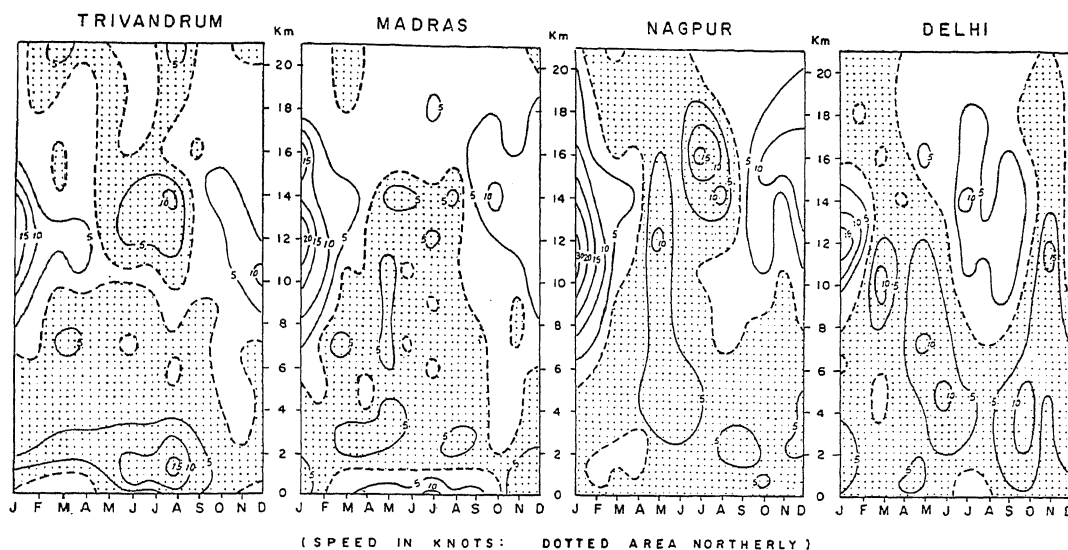


FIG. 1

MERIDIONAL WINDS - TRIVANDRUM 1963

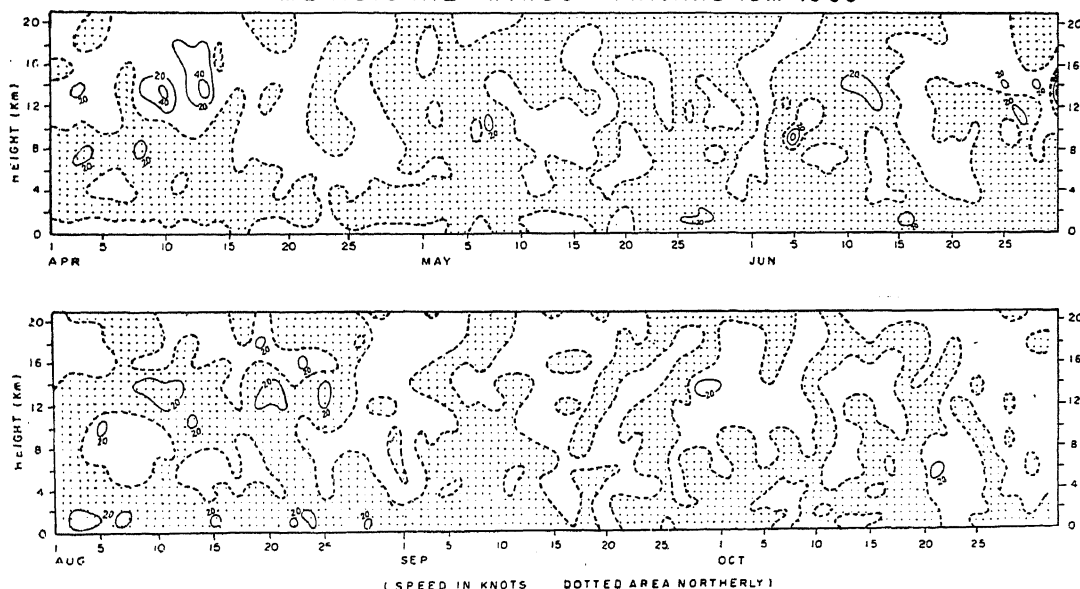


FIG. 2

- (ii) Excluding the first 1 or 2 kilometres, alternate spells of northerlies and southerlies occur at all stations, at all levels, in all the months.
- (iii) In the lower troposphere the circulation is predominantly northerly at all stations throughout the period under study.
- (iv) At Trivandrum, Madras and Nagpur the

upper tropospheric circulation shifts from predominantly southerly to predominantly northerly flow by about the middle of May. This feature continues till the middle of August after which the circulation undergoes reversal. Over Delhi the upper tropospheric circulation is predominantly northerly from April

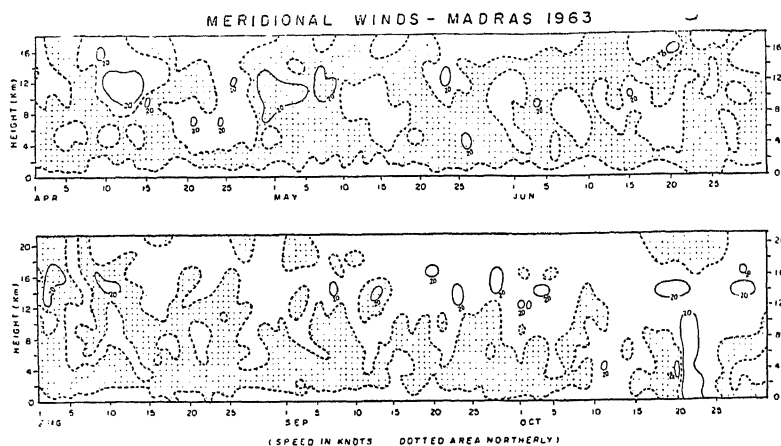


FIG. 3

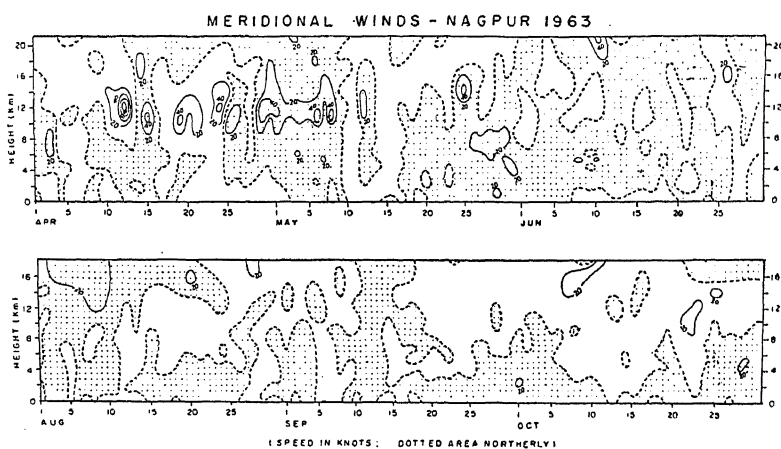


FIG. 4

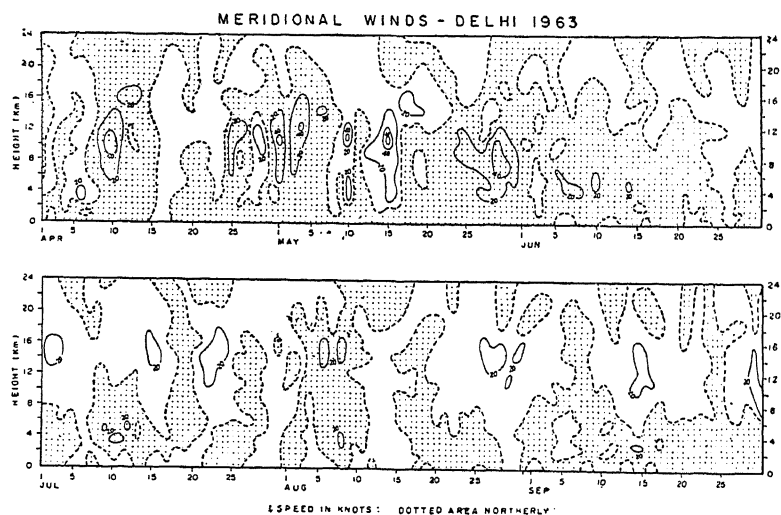


FIG. 5

to the middle of June. Later the southerly circulation gains predominance till the end of September.

I. Ananthakrishnan, R. and Ramakrishnan, A. R.,  
*Curr. Sci.*, 1964, 33, 543.



## ELEVENTH INTERNATIONAL CONGRESS OF APPLIED MECHANICS, MUNICH

**T**HE International Union of Theoretical and Applied Mechanics (IUTAM) holds an International Congress once in four years. The last one was held in St.essa, Italy, in 1960. Between two Congresses a number of symposia on live subjects like Boundary Layer, Shell Theory, Non-linear Elasticity and Plasticity, Gas Dynamics, and Continuum Mechanics, are sponsored by it in various parts of the world to highlight their importance.

The 11th Congress was held in Munich from August 30 to September 5, 1964, and was sponsored by IUTAM and 21 German Organizations. More than 1,200 delegates from 35 countries attended the Congress. They were divided into speakers and participants. The Speakers included L. I. Sedov, G. I. Taylor, I. N. Vekua, N. J. Hoff, H. W. Liepmann, B. R. Seth, J. N. Goodier, W. Prager, W. Olszak, G. F. Carrier, E. Reissner, P. M. Naghdi, C. Truesdell, A. C. Eringen, H. Neuber, H. Ziegler, K. Magnus, R. Legendre and T. Benjamin.

There were nine general lectures to review the present state of subjects like new models in continuum mechanics, thermodynamics of deformation, shell theory, rotating fluids, wave propagation, and flow with flexible boundaries. The concept of transition in irreversible processes like elastic plastic deformation, creep, relaxation, boundary layer, shocks claimed a number of papers.

Transition concepts were presented in a number of papers on Fluid Mechanics. But B. R. Seth was the one to develop it in Solid Mechanics. Combined with that of generalised strain he showed how to do away with semi-empirical conditions like yield conditions and creep strain laws. His paper on generalised strain and transition concepts for elastic plastic deformation, creep and relaxation aroused great interest as the new concepts contained in the paper could be exploited in a number of fields.

The designing of new models for continuum media was stressed by L. I. Sedov. All such models should ensure the symmetric concept of elementary particles through tensorial representation. At present simple tensor systems have been established for all such groups of the complete orthogonal group. For non-holonomic systems it is pointed out that the free energy should be taken as a function of the stress and strain tensors, temperature and response coefficients.

Internal couple-stresses are introduced to explain high stress gradients in fatigue. A. C. Eringen showed how they may be used for treatment of anisotropic fluids. R. A. Toupin and H. Neuber also dealt with similar problems.

G. I. Taylor showed how disintegrating drops of fluid develop conical surfaces when they are torn by strong electric fields or by the motion of surrounding fluid of higher viscosity. Both theoretical and experimental considerations show that equilibrium conditions can be satisfied at a conical surface when the cone has a semi-vertical angle of  $49.3^\circ$ . The Boltzmann's equation was the subject of a number of papers. H. W. Liepmann dealt with its modified form based on the Krook model. He showed that such an approximation gives good results for the shock structure problem.

Rotating fluids tend to rotate rigidly when the container speed is suddenly changed. This and similar problems in the formation of weather fronts and ocean currents were discussed by G. F. Carrier. The instability of rotating compressible fluids was used by J. W. Miles to show that zonal wind in the middle latitudes were unstable for almost all wavelengths, and that the corresponding disturbances derived their energy from "over-turning" and through the mean flow through a Reynolds-stress-like-mechanism in the "critical layer". In like manner, N. Rott and W. S. Lewellen related the tornado problem to the interaction of the boundary layer and the outer flow in rotating fluids. R. C. Di Prima and J. T. Stewart gave a non-linear analysis of the stability of the Taylor vortex and wavy modes of motion, and extended this analysis to the explanation of the occurrence of a second critical speed and non-symmetric wavy motion.

Visits to various Institutes were arranged during the Congress of which particular mention may be made of the Max Planck Institute of Physics and the Institute of Plasma Physics.

The next symposium to be sponsored by IUTAM will be held in Paris from April 20 to 24, 1965. The next meeting of the General Assembly will be held in Vienna in 1966 close to the Symposium on Irreversible Aspects in Continuum Mechanics.

Indian Institute of Technology,      B. R. SETH.  
Kharagpur.

## LETTERS TO THE EDITOR

DAILY VARIATION OF COSMIC RAY  
INTENSITY ASSOCIATED WITH  
SOLAR DISTURBANCES

AN investigation of daily variation of cosmic ray intensity associated with solar activity is made for the IGY period. The solar flare index for each day published by Dodson and Hedeman (1961) is used for the purpose. According to these authors the flare index during the 549 days of IGY varied from 0 to 47.9. Days for which the index is greater than 25 are taken as high index days. There were 36 high index days distributed throughout the IGY.

Cosmic ray nucleonic intensity data collected at Deep River (Geomagnetic Lat.  $57^{\circ}.5$ , Geographic Long.  $70^{\circ}.5$  W) and Yakutsk (Geomagnetic Lat.  $51^{\circ}.0$ , Geographic Long.  $129^{\circ}.7$  E.) during the IGY are used in the present study.

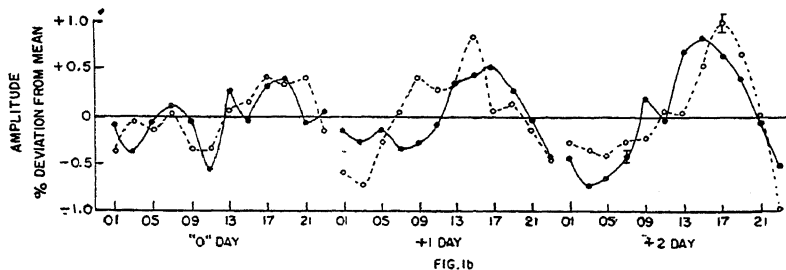
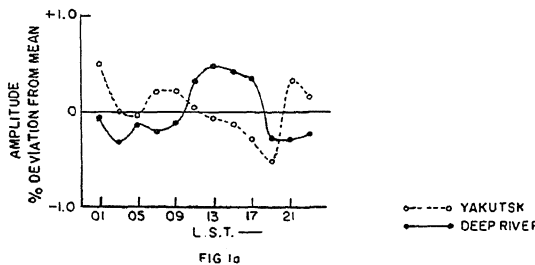
The daily variation on days of low flare index is shown in Fig. 1a. In Fig. 1b are shown the

taneously are used. Due to this only 27 out of the 36 high index days could be used in the analysis. The amplitudes and phases ( $r_1$  and  $t_1$ ) calculated by harmonic analysis are given in Table I.

TABLE I

Name of Station	Day	$r_1\%$	$t_1$	
			Hrs.	Min.
Deep River	.. 0	$0.15 \pm 0.05$	15	42
	+1	$0.38 \pm 0.05$	14	58
	+2	$0.72 \pm 0.05$	14	09
Yakutsk	.. 0	$0.29 \pm 0.08$	17	58
	+1	$0.46 \pm 0.08$	13	24
	+2	$0.56 \pm 0.08$	14	12

Firor (1954) found that the mean daily cycle of cosmic ray intensity depends on the rate of flares occurring on the sun. He showed that the intensity curve is peaked during early morning hours for flare periods relative to periods in



DAILY VARIATION AROUND LOW AND HIGH FLARE INDEX DAYS

average daily variation on days of high flare index (0 day) and subsequent two days (+1, +2 days) for each of the two stations. The daily variations are corrected for linear gradients at each of the two stations and also Universal Time Worldwide effects. The methods suggested by Yoshida (1956) and Kane (1961) are used for correcting. Only days for which cosmic ray data are available at both the stations simul-

which few or no flares occurred. Towle and Lockwood (1959) on the other hand found no such variations. The results reported here agree with those of Firor (1954) in the existence of a subsidiary maximum during high flare index days. The apparent increase in amplitude on days following high flare index days suggests that it may be due to solar controlled modulation of existing cosmic ray flux.

The author wishes to thank Prof. Hugh Carmichael and the National Committee for IGY, Japan, for supplying the data of Deep River and Yakutsk respectively. He also wishes to thank Prof. S. Bhagavantam for his interest, in whose laboratory this work was done.

Yale University Observatory, CH. V. SASTRY.\*  
New Haven, Conn. U.S.A.,  
October 28, 1963.

\* Formerly at the Director's Research Laboratory, Indian Institute of Science, Bangalore, India.

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### THE MEAN SQUARE AMPLITUDES OF VIBRATION IN $\text{BrO}_3$ , $\text{IO}_3$ AND $\text{SiBr}_3$ MOLECULES

THE theory of vibrational mean square amplitudes<sup>1</sup> for the bent symmetrical  $\text{XY}_2$ <sup>2,3</sup> and planar symmetrical  $\text{XY}_3$ <sup>4</sup> type molecules have

been applied to study the mean amplitudes of vibration, Coriolis coupling constants and bond shrinkage effects in a few molecules and ions.

The present investigation deals with the application of the above method to a few of  $\text{XY}_3$  type pyramidal molecules:  $\text{BrO}_3$ ,  $\text{IO}_3$  and  $\text{SiBr}_3$ . These molecules belong to  $C_{3v}$  symmetry and the six vibrations are classified as two totally symmetric  $A_1$  and two doubly degenerate E modes. The calculated vibrational frequencies using the previously reported potential constants<sup>5</sup> are used in evaluation of general symmetrised mean square amplitudes with the help of the secular equation,  $|\Sigma G - E \Delta| L_k = 0$ .<sup>\*</sup> The general symmetrised mean square amplitudes at two temperatures  $T = 0^\circ$  and  $T = 298^\circ \text{K}$ . are given in Table I. The individual mean square amplitude quantities  $\sigma$ 's are also evaluated and given in Tables II and III.

The authors are deeply indebted to Prof. K. R. Rao, Professor Emeritus, Andhra University, for his kind interest and encouragement during the course of the work. One of the authors (C. G. R.) is thankful to the Council of Scientific and Industrial Research for the award of a Junior Research Fellowship.

TABLE I  
 $\Sigma$  Matrices ( $\text{\AA}^2$ )

	$\Sigma_{11}$	$\Sigma_{22}$	$\Sigma_{12}$	$\Sigma_{33}$	$\Sigma_{44}$	$\Sigma_{34}$
$\text{BrO}_3$ { $T = 0^\circ$	0.001604	0.00644	-0.0003489	0.001528	0.006484	-0.00008756
{ $T = 298^\circ \text{K}$ .	0.001681	0.008086	-0.0002667	0.001534	0.009358	-0.0000645
$\text{IO}_3$ { $T = 0^\circ$	0.001526	0.001989	-0.0002364	0.001461	0.006769	-0.00005643
{ $T = 298^\circ \text{K}$ .	0.0016	0.01052	-0.0001703	0.001524	0.01028	-0.00004742
$\text{SiBr}_3$ { $T = 0^\circ$	0.001292	0.006319	-0.000971	0.002221	0.009194	-0.001964
{ $T = 298^\circ \text{K}$ .	0.002223	0.01183	-0.000305	0.002984	0.02602	-0.000847

TABLE II  
Individual mean square amplitude quantities ( $\text{\AA}^2$ )

	$\sigma_r$	$\sigma_d$	$\sigma_{rd}$	$\sigma_{rr}$	$\sigma_{dd}$	$\sigma_{rd^2}$
$\text{BrO}_3$ { $T = 0^\circ$	0.001553	0.006499	-0.0001455	0.00002533	-0.00001466	-0.00005794
{ $T = 298^\circ \text{K}$ .	0.001616	0.008934	-0.0001104	0.0000322	-0.000424	-0.0000459
$\text{IO}_3$ { $T = 0^\circ$	0.001485	0.005176	0.00009761	0.00002067	-0.001593	-0.00004118
{ $T = 298^\circ \text{K}$ .	0.001549	0.01036	-0.00007024	0.00002383	0.00008	-0.00002982
$\text{SiBr}_3$ { $T = 0$	0.001911	0.008234	-0.0009783	-0.0003097	-0.0009583	0.0009857
{ $T = 298^\circ \text{K}$ .	0.00273	0.02129	-0.000394	-0.0002537	-0.00473	0.000463

TABLE III  
Additional mean square amplitude quantities ( $\text{\AA}^2$ )

		$\sigma_d$	$\sigma_{dd}$	$\sigma_{rd}$	$\sigma_{rd'}$
BrO <sub>3</sub>	T=0°	0.00297	0.0005714	0.001093	-0.0000078
	T=298° K.	0.005499	-0.000118	0.001076	0.00001235
IO <sub>3</sub>	T=0°	0.003316	-0.001949	0.000854	-0.00000639
	T=298° K.	0.006765	0.0007206	0.001054	0.00001427
SiCr <sub>3</sub>	T=0°	0.003019	-0.0002731	0.0007509	0.0000579
	T=2.5° K.	0.009006	-0.000198	0.001800	-0.00015

Spectroscopy Research  
Laboratory,  
Andhra University,  
Waltair, October 6, 1964.

C. G. RAMA RAO.  
C. SANTHAMMA.

Recently Eichler<sup>1</sup> has studied  $\varepsilon^-$  levels of even-even nuclei and makes the interesting observation that the log ft value of allowed beta-transitions to these  $\varepsilon^-$  levels is in general larger than the average value implying hindrance.

We have carried out a similar analysis on 5- levels. Table I shows our attempt. The various columns are self-explanatory. The value given in the seventh column is an average over several allowed transitions in the neighbourhood.

From Table I we conclude that there is neither enhancement nor hindrance in direct contrast to Eichler's study of  $\varepsilon^-$  levels.

Department of Physics, S. SWARNAGOWRI.  
Karnatak University, M. K. RAMASWAMY.  
Dharwar-3, September 29, 1964.

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### SYSTEMATICS OF 5- LEVELS OF EVEN-EVEN NUCLEI

THE most common mode of collective vibration of even-even nuclei is the  $\lambda = 2$  quadrupole type. Of the less common ones we have  $\lambda = 3$  mode giving rise to 3- state and  $\lambda = 5$  mode giving rise to 5- level.

TABLE I

Log ft values of allowed  $\beta$ -transitions to 5- levels of even-even nuclei

Parent Nucleus	Spin and Parity	Daughter Nucleus	Type of decay	Energy of 5- level in Mev.	Log ft	Log ft (Average)	Ref.
1	2	3	4	5	6	7	8
1 <sup>30</sup> Y <sub>47</sub> <sup>86</sup>	4-	38 <sup>32</sup> Y <sub>43</sub> <sup>87</sup>	$\beta^+$	2.58	5.9	6.2	1
2 <sup>47</sup> Ag <sub>63</sub> <sup>110</sup>	6-	48 <sup>48</sup> Cd <sub>62</sub> <sup>110</sup>	$\beta^-$	2.93	5.4	4.9	2
3 <sup>63</sup> Eu <sub>83</sub> <sup>146</sup>	(4-)	62 <sup>62</sup> Sm <sub>84</sub> <sup>146</sup>	$\beta^+$	2.05 (a)	7.8	8.8	3
4 <sup>63</sup> Eu <sub>83</sub> <sup>148</sup>	(4-)	62 <sup>62</sup> Sm <sub>84</sub> <sup>148</sup>	$\epsilon$	1.6	9.0	8.8	4
5 <sup>67</sup> Ho <sub>95</sub> <sup>162</sup>	(6-)	67 <sup>67</sup> Er <sub>96</sub> <sup>162</sup>	$\epsilon$	1.49	4.6	4.7	5
6 <sup>85</sup> At <sub>125</sub> <sup>210</sup>	(0-, 5-, 4-)	84 <sup>84</sup> Po <sub>126</sub> <sup>210</sup>	$\epsilon$	2.92	5.9	6.0 (b)	6

(a) Parity is most probably odd; (b) As there are no allowed transitions in this neighbourhood and since the average log ft value for first forbidden transitions is about 6.5, we have taken an average of 6.0 for an allowed transition.

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DUSTFALL AND SOOTFALL STUDY IN  
AHMEDABAD AREA

MINERAL soil particles, sea-spray particles and various kinds of smokes are important sources of aerosols. These smokes are primarily responsible for the Aitken condensation nuclei. Junge<sup>1</sup> reports that on an average about 80% of the particle material is insoluble mineral dust and tarry substances from incomplete combustion, or soot; the rest being soluble salts. It is also confirmed by observations at various stations that sulphate, in combination with ammonium and calcium, is a major soluble component of continental aerosols; the aerosols above the marine areas being rich in sodium chloride.

The problem of air pollution is highly acute in industrial areas. Ahmedabad is one of the major industrial towns of India, famous for its textile industry. Almost all the textile mills in the area consume huge amounts of coal. This is an important source of atmospheric pollution in this industrial campus. Hence it was decided to study the problem of air pollution in the city of Ahmedabad. To start with, the dustfall and sootfall measurements were taken following Jacobs.<sup>2</sup> Eight sites were selected to cover an area of about 16 square miles. The Los Angeles Method<sup>3</sup> was used to collect the samples for sootfall and dustfall analysis. A polythene jar with a diameter of 3.5 inches was filled with 1,000 ml. of distilled water and placed on the terraces of tall buildings. The jar was kept exposed for a period of 30 days, and the sample so collected was examined for various soluble and insoluble constituents. Insoluble matter (W) was determined by filtering the contents of the jar through the gooch crucible and weighing it after drying at 105° C. The tar is estimated as a difference between W and the weight of the matter that remains insoluble on treatment of W with carbon disulphide. Ash is determined by igniting the contents of the crucible at 750° C. Chloride is estimated volumetrically by Vohlard's method, sulphate is estimated either gravimetrically or turbidimetrically by barium sulphate method. Some of the analytical data obtained for a single collection in the preliminary experiment are presented in Table I. The samples were collected during the period, 1st June 1963 to 30th June 1963.

## DISCUSSION

Sample Nos. 1, 3, 7, 8 are representative of the industrial area, where a large number of textile mills are located. On using the formula ( $T = 5650 W/D^2$ , where W = weight of matter

TABLE I  
Estimation of tar, ash, chloride and sulphate

No.	Location	Insoluble matter (in gm.)	Tar (in gm.)	Ash (in gm.)	Chloride (in mgm.)	Sulphate (in mgm.)
1	Naroda ..	0.135	0.032	0.085	10.4	20.0
2	Shahpur ..	0.120	0.003	0.091	5.8	5.9
3	Asarva ..	0.046	0.05	0.040	4.9	5.1
4	Dariapur ..	0.153	0.004	0.074	6.0	8.4
5	Paldi ..	0.094	0.004	0.049	4.1	4.8
6	Rajpur ..	0.085	0.003	0.068	5.6	10.9
7	Maninagar ..	0.081	0.004	0.033	17.3	15.2
8	Jamalpur ..	0.116	0.005	0.040	4.0	5.5

in grams and D = diameter of jar in inches), to compute (T) the amount of insoluble matter in tons per square mile per month, it is found that on an average 47.5 tons of insoluble matter is deposited per square mile per month in the Ahmedabad area. While in Dariapur locality where it is the highest, the value comes out to be 80.9 tons of insoluble matter per square mile per month. Greenburg and Jacobs<sup>4</sup> and Jacobs and Donovan<sup>5</sup> have reported 160 tons per square mile per month as the highest value and 60 tons per square mile per month as the lowest value for solid matter deposited from the atmosphere for the New York City. Hence it can be seen that values of dustfall and sootfall for Ahmedabad area are comparable to the lower limits for the New York City. Even then these figures do not represent the total emission of solids, which will be extremely high as compared to these values, because the total solids determined as sootfall is only a fraction of the total emission of solids. It is not possible to draw any conclusion regarding the mechanism of formation of sulphate as well as the possibility of high proportions of chloride in a continental area such as this.

Our thanks are due to Prof. B. K. Vaidya and Dr. J. C. Vora for their interest in the work.

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### ON PREPARATION OF QUINHYDRONE BY ANODIC OXIDATION OF HYDROQUINONE

QUINHYDRONE is usually prepared by the oxidation of hydroquinone with ferric alum (Vogel<sup>1</sup>). In a recent communication, Khulbe and Srivastava<sup>2</sup> have reported the production of quinhydrone by the use of potassium persulphate. Anodic oxidation of hydroquinone in acidified aqueous solution described in the present note was found successful under conditions of low amperage and low temperature.

5.0 gm. of pure hydroquinone, dissolved in 75 ml. of conductivity water, acidified with few drops of A.R. conc. sulphuric acid, was electrolysed between platinum plate electrodes (1.00 cm.  $\times$  0.75 cm.  $\times$  0.30 mm.) in a cell 8 cm. long and of 4½ cm. diameter. The electrode plates were spaced 2.5 cm. apart. The anodic oxidation was carried out at 15 volts with 0.4 ampere current. The formation of quinhydrone crystals was seen almost immediately at the anode and liberation of hydrogen at cathode. The direction of the current was reversed for a period of 15 seconds after every 15 minutes, to facilitate the removal of crystals from the electrodes. The contents of the cell were kept stirred in a bath of ice-cold water during electrolysis. After three hours continuous electrolysis, the deposition of quinhydrone seemed to stop. The cell liquid was tested for the absence of hydroquinone with potassium persulphate.<sup>2</sup> No green needles of quinhydrone appeared. The cell was disconnected from the mains and kept in the refrigerator for half an hour which helped in the separation of quinhydrone which was then filtered under suction and washed twice with ice-cold water. The crystals were dried in a desiccator overnight. The yield of quinhydrone (m.p. 171° C.) was 3.2 gm. The constitution of the substance was further confirmed by mixed m.p. with authentic specimen.

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Department of Chemistry, G. L. GUPTA.  
Motilal Vigyan Mahavidyalaya,  
Bhopal, August 11, 1964.

### TERMINAL AMINO-ACIDS OF THE HAEMOGLOBIN OF INDIAN COW

THE terminal structures of haemoglobins of several species of mammals have been much studied<sup>1-3</sup> since the original work by Porter and Sanger.<sup>4</sup> Ozawa and Satatke<sup>5</sup> extended their studies to lower classes of vertebrates (horse, pig, dog, cat, rabbit, guinea-pig; rat; chicken and snake) and found that all the haemoglobins have valine as the N-terminal residue while that of ruminants (bovine, sheep and goat) have methionine in addition to valine.

The variety of C-terminal amino-acids of mammalian haemoglobins also seem to be rather limited. Huisman *et al.*<sup>6</sup> have reported the C-terminal residues of normal human adult haemoglobins, and many abnormal haemoglobins, as Histidine and Tyrosine.

The present account deals with the terminal amino-acids of the haemoglobin of Indian cow. The haemoglobin was prepared from citrated cow blood according to the method of Huisman *et al.*<sup>7</sup> The N-terminal amino-acids were analysed following the method of Fraenkel-Conrat<sup>8</sup> and the C-terminal amino-acids were analysed according to the method of Yagy *et al.*<sup>9</sup>

The results are presented in Table I.

TABLE I  
Terminal amino-acids of Indian cow haemoglobin

Terminal position	Method	Amino-acids encountered	Moles of amino-acids/mole of haemoglobin Mol. wt. 68,000
C-terminus	(i) Carboxy peptidase method	Histidine and Tyrosine	0.92 0.90
	(ii) Hydrazinolysis	Histidine and Tyrosine (Qualitative)	..
N-terminus	Fluorodinitrobenzene method <sup>8</sup>	Valine and Methionine	2.0 2.0

It is evident from the results given in Table I that the N-terminal amino-acids in cow haemoglobin molecule contains two moles each of valine and methionine. Histidine and tyrosine are found to be the C-terminal residues. Carboxy peptidase digestion reveals the presence of serine, glycine, alanine and leucine also which may be present as adjacent amino-acids.

Kauffmann and Fitz Peter<sup>10</sup> have reported that all human, horse and bovine haemoglobins contain only two moles of histidine and no tyrosine. But in our investigation we find the presence of tyrosine also to the extent of one mole per mole

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of hæmoglobin. In this respect our results agree well with that of Huisman *et al.*<sup>6</sup>

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### EFFECT OF THYMINE ON VITAMIN B<sub>12</sub> AND FOLIC ACID SYNTHESIS

GROWTH STUDIES with micro-organisms requiring vitamin B<sub>12</sub> and folic acid first suggested their involvement in the biosynthesis of purines and thymine.<sup>1-4</sup> Enzymatic studies later served to prove conclusively the role of folate derivatives in the building up of the purine ring and in the methylation of the uracil moiety.<sup>5</sup> The partial replacement of vitamin B<sub>12</sub> in the nutrition of *Lactobacillus leichmannii* by deoxyribosides and deoxyribotides of purines and cytosine was later attributed to the role of this vitamin in the synthesis of deoxyribose.<sup>6</sup> The present studies report the influence of thymine on the *de novo* synthesis of these two vitamins by a thymine auxotroph, *Escherichia coli* 15 T<sup>-</sup>.

Salts-dextrose medium<sup>7</sup> supplemented with sub-optimal and optimal amounts of thymine was used to grow these cells. Folic acid and vitamin B<sub>12</sub> were liberated from harvested cells and culture fluid, and assayed with *Streptococcus faecalis* R. and *Lactobacillus leichmannii* 313 according to the procedures recommended by Mitbander and Sreenivasan<sup>8</sup> and Skeggs *et al.*<sup>9</sup> respectively. Results reported in Table I indicate that when the organism was grown in sub-optimal concentration of thymine, there was increased *de novo* synthesis of both the vitamins. However, nucleic acid content of the optimally grown cells was higher.

TABLE I

Effect of thymine variation on folic acid, vitamin B<sub>12</sub> and nucleic acids in *E. coli* 15 T<sup>-</sup> (Thymine auxotroph)

Thymine added µg./ml.	Cell mass mg./l	Folic acid µg./mg. dry weight cells		Vitamin B <sub>12</sub> activity µg./mg. dry weight cells		RNA %	DNA %
		Cells	Culture fluid	Cells	Culture fluid		
125	72	1.51	13.9	190	1600	6.8	3.6
500	143	0.77	12.9	57	300	8.6	3.9

*E. coli* 15 T<sup>-</sup> lacks<sup>10</sup> an enzyme thymidylate synthetase, which requires tetrahydrofolate coenzymes. Tetrahydrofolic acid does not support the growth of this organism. It is possible that limiting amount of thymine limits the deoxyribonucleic acid synthesis and cell-division, while the cytoplasmic synthesis continues unabated.<sup>11</sup> This might result in increased synthesis of essential cofactors. The cells are known to grow into "snakes" under these conditions.<sup>11</sup> Alternatively, this could be a case of feed-back inhibition or repression of the enzyme systems catalyzing the synthesis of the two vitamins.

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### FLOWERS OF *COUROUPITA* *GUIANENSIS* AUBL.

VERY little chemical investigation of the plant *Couroupita guianensis* seems to have been done in the past. Some constituents of the fruit<sup>1</sup> and the composition of the seed oil<sup>2</sup> have been reported.

The large beautiful flowers, with a peculiar floral structure, have a fragrance closely resembling that of the "Damask Rose". Steam distillation of the flowers, however, resulted in decomposition of the essential oil and a product with an unpleasant burnt rubber-like odour was obtained. Extraction with solvents like ether gave a concrete (0.3%) which, though pleasant smelling, did not resemble the original fragrance of the flower. Direct distillation with water, under vacuum, was the only method by which a product, resembling the flower in smell, was obtained. The amount of oil so prepared was, however, too small for further investigation.

The petals are dark red on the inner surface and pale yellow on the outer surface. The base of the flower is tinted a beautiful pink. On exposure to ammonia vapour, the inner surface and base become dark blue and the outer surface, bright yellow. This shows the flavonoid nature of the pigments. The pigments were extracted with 1% HCl and chromatographed before and after acid hydrolysis using conventional solvent systems (Butanol-acetic-water, 15% acetic acid, Forestal solvent and 1% HCl). The  $R_f$  values and colour reactions of the different spots pointed to the anthocyanins (two) being pelargonidin glycosides and flavonols (three) being glycosides of quercetin and Kaemferol.

The most interesting observation is that all the parts of the flower, when cut or crushed, quickly turn deep blue in colour. The deep blue colour formed is not soluble in water, alcohol or ether. It is soluble in chloroform and acetic acid. The dark dried paste of the ground-up flowers was repeatedly extracted with boiling alcohol to remove the other pigments and then refluxed with chloroform. The deep blue solution from this gave, on evaporation, a blue-black powder. The physical and chemical properties of this powder showed it to be identical with indigotin. There seems to be an enzyme involved in the conversion of the leuco-compound to indigo, since blanching of the flowers with boiling water or alcohol greatly reduces the colour formation. Isolation of the colourless precursor is rendered difficult by the enzyme and other pigments present. The leaves

and stems of the plant were not found to contain any such precursor.

This is the first time that indigo formation has been found responsible for the discoloration of a flower.

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Spices and Flavour Technology      Y. S. LEWIS.  
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Central Food Technological  
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### DIAGENETIC DEDOLOMITISATION IN THE KROL SERIES\*

DURING the course of petrographic investigations in the carbonate rocks of the Krol Series (Auden, 1934) exposed between Mussoorie (30° 27' 46" : 78° 3' 47") and Lansdowne (29° 50' 22" : 78° 41' 17") abundant evidences of initial stages of diagenetic dedolomitisation were observed in Krol 'D' and 'E' dolomites particularly along Gungadhera Nala, near Banghat (29° 58' : 78° 13' 30"), Garhwal District, U.P. The rock is a hard, compact, massively bedded, dull, dark bluish-grey dolomicrite to calcic dolomicrite (low reaction to 1:10 dilute hydrochloric acid: Motts, 1961) with abundant calcite veins and isolated rounded to oval spots made up of aggregates of calcite plates. The veins are thin, impersistent, anastomosing and gradually taper off into the host rock. The contact between the veins and the host rock is either gradational or abrupt and sharp. In places where the calcite veins are abundant, they show a somewhat sub-parallel arrangement. The ovoidal to circular whitish spots made up of calcite aggregates vary in size from that of a mustard to the size of a pea. Wherever the spots are abundant and closely spaced, the rock takes on a blistered appearance. Associated in the field with these rocks, are intensely brecciated zones where angular fragments of dolomicrite to calcic dolomicrite are seen embedded in a cream-coloured, soft, porous, medium to fine-grained highly calcic matrix.

Under the microscope evidences of dedolomitisation are striking. The rock shows a buff-coloured dolomicritic to calcic dolomicritic matrix in which are disposed isolated spots made up of aggregates of xenomorphic brownish



calcite plates and veins. Both the spots and the veins show all stages of development from the initial hazy patches to well-formed spots and veins with clear and well-defined borders. The spots and veins sometimes show undigested remnants of dolomiticite to calcic dolomiticite host material.

Diagenetic dolomitisation of limestones is a commonly observed phenomenon but diagenetic dedolomitisation of dolomites is a rare feature. Only two instances are known in the English literature, one reported by Takarsky (1949) and the other by Chilingar (1956). For the first time evidences of diagenetic dedolomitisation are recorded from India.

R. and T. Institute, C. GUNDU RAO.  
O.N.G. Commission,  
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\* Published by permission of the Director, R. & T. Institute, Oil and Natural Gas Commission, Dehra Dun.

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#### THE STRATIGRAPHICAL POSITION OF THE BEHALI COAL SEAM DISTRICT DARRANG, ASSAM

A SAMPLE of coal collected from the Behali Reserve Forest, at the Himalayan foothills in Darrang District analysed with the following result, viz., moisture 12.9%, ash 3.8%, volatile matter (VM) 45.0% and fixed carbon (FC) 38.3%.<sup>1</sup> The amount of volatile matter in the coal was surprising for the only coal-bearing rocks in these regions are the Damudas and Damuda coals do not have such high volatiles. Immediately to the east Godwin Austen<sup>2</sup> found Damudas in the Daphla Hills. To the immediate west are the coal-bearing Damudas of Maj-Bhorali and Balukpung found by La Touche.<sup>3</sup> Further west in the Bhutan foothills Pilgrim<sup>4</sup> found Damuda coal analysing as follows: moisture 1.82%, ash 24.25%, volatile matter 19.06% and fixed carbon 54.87%. On a VM/FC ratio of 17:40 Fox<sup>5</sup> assigned the Singrimari exposure in Garo Hills to the Barakar Series. Even coal from the Raniganj Series has only a VM/FC ratio of 17:28.53 as against 17:13.45 of the Behali coal.

It was, therefore, necessary to find out if this VM:FC ratio is matched by coal from any

other horizons in Assam. The following table gives the VM:FC ratios of the coals of Assam:

1. Coal from Tipam Series (from recent boreholes only)<sup>6</sup> .. 17:10.37
2. Coal from Tikak Parbat Stage .. 17:20.23
3. Coal from the Cherra Stage .. 17:14.79

The comparatively low VM:FC ratio of the Tikak Parbat coal is due to the fact that the Makum Coalfield is involved in large-scale folding. Only coal from the Cherra Stage has a ratio approaching that of the Behali coal. Yet, Sale and Evans<sup>7</sup> have reported that only rocks of the Surma and Tipam Series are exposed at the foothills.

The only possible explanation appears to be that rocks of the Cherra Stage, from which the Behali coal seams have come, have not, so far, been identified at the foothills being unfossiliferous.

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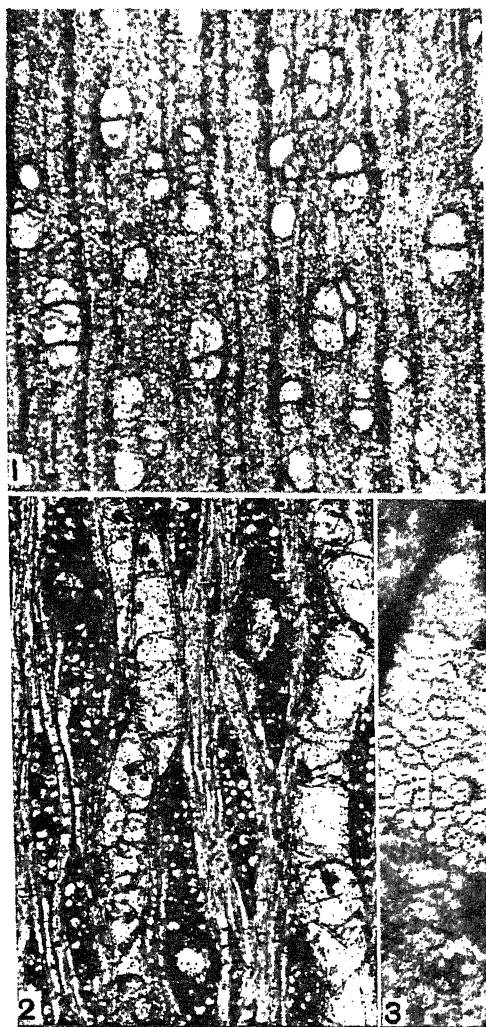
#### OCCURRENCE OF BOSWELLIA IN THE DECCAN INTERTRAPPEAN BEDS OF KERIA, MADHYA PRADESH

In the present communication, I wish to record the finding of an hitherto unknown fossil wood recalling the modern genus *Boswellia* Roxb. of the family Burseraceae. It was collected in February 1961 from Keria (21° 59' 40" N.; 79° 10' 15" E.), a locality of the Deccan Inter-trappean Series.

The material investigated comprised two petrified pieces of well-preserved decorticated secondary wood. They have been studied in detail from their thin ground sections and the following important anatomical details have been observed.

Wood diffuse-porous (Fig. 1). *Growth rings* not observed. *Vessels* small to medium-sized, t.d. 60-180  $\mu$ , r.d. 75-210  $\mu$ , solitary and in radial multiples of 2-4 or more cells, sometimes in short double rows and small clusters, 10-22 per sq. mm. (Fig. 1), profusely tylosed (Figs. 1 and 2); vessel-members with truncate or slightly tapered ends; perforations simple; intervessel pit-pairs large, 8-10  $\mu$  in diameter, bordered,

border hexagonal due to crowding, aperture linear and horizontal (Fig. 3). Parenchyma



FIGS. 1-3. *Boswellioxylon indicum* gen. et sp. nov. Fig. 1. Cross-section of the fossil wood showing shape, size and distribution of the vessels,  $\times 50$ . Fig. 2. Tangential longitudinal section showing the xylem rays, radial intercellular canals, septate fibres and tyloses in the vessels,  $\times 100$ . Fig. 3. Intervessel pit-pairs,  $\times 440$ . scanty-paratracheal, difficult to locate even under the microscope, occurring as few cells about some vessels. Xylem rays fine to broad, 1-6 (mostly 2-4) seriate and  $16-90\mu$  wide, 8-13 per mm. (Fig. 2); ray tissue heterogeneous; uniseriate rays very few, 4-6 cells and up to  $100\mu$  high, often composed of upright cells only; multiseriate rays heterocellular, consisting of procumbent cells in the thickened part, with 1-2 marginal rows of upright cells,  $90-675\mu$  high, with intercellular canals (Fig. 2); upright cells

without any crystals. Fibres moderately thick-walled, septate (Fig. 2). Intercellular canals of radial type (Fig. 2), 0-10 per sq. mm., commonly roundish to broadly elliptic as seen in tangential longitudinal sections, canal orifice up to  $105\mu$  in diameter.

A detailed examination of the modern woods with radial intercellular canals<sup>1</sup> as well as the published literature<sup>2-5</sup> has revealed that the present fossil wood is closely allied to the modern genus *Boswellia* Roxb., especially *B. serrata* Roxb. (Forest Research Institute slide No. A 1741), of the family Burseraceae. It also shows a somewhat close resemblance in gross features to the genera *Lannea* (Anacardiaceae) and *Garuga* (Burseraceae). However, there are some important anatomical details which distinguish the Intertrappean fossil from these genera. In the modern species of *Lannea* examined the radial canals are occasional, so much so that in many of the samples examined the canals are rare or absent; their frequency is very low (0-2 per sq. mm.); and the marginal upright cells of the rays are crystalliferous and conspicuous in the tangential longitudinal sections. Similarly, the genus *Garuga* is also distinguished from the present fossil wood by its vessels which are always large and the marginal upright cells of the rays are crystalliferous and conspicuous in the tangential longitudinal sections. The frequency of the radial canals, as has been examined in *Garuga pinnata*, is very low (0-2 per sq. mm.).

I am not aware of any published record of the fossil wood resembling the modern *Boswellia* and hence I am describing the present wood from Keria as *Boswellioxylon indicum* gen. et sp. nov. The specific name signifies its occurrence in the Indian sediments.

I am greatly indebted to Dr. R. N. Lakhanpal for his guidance. I am also grateful to Shri K. Ramesh Rao, Forest Research Institute, Dehra Dun, for helpful suggestions and laboratory facilities.

Birbal Sahni Institute of  
Palaeobotany,  
Lucknow, India, July 22, 1964.

R. DAYAL.

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# SUBMARINE CANYONS OFF MADRAS COAST

IN the recent 15th Scientific Cruise of INS KISTNA (June 8-20, 1964), as part of the International Indian Ocean Expedition Programme, the writer participated in geological exploration. A series of submarine canyons were identified and interpreted from the echograms taken with an Edo Echosounder. These stretch to a distance of about 45 nautical miles across, off the coast of Madras (between 12° 13' 30" N, 80° 20' E. and 11° 30' N, 79° 58' )—between 35 miles northeast of Pondichery and 12 miles east of Porto Novo. It is known that in this region the 100-fathom line bends near to the coast in several places (Shepard, 1963, p. 238).

These submarine canyons, so far noticed, are in two sets and each consists of hill-like projections and V-shaped valleys. The height of the ridges ranges from 300-2,400 feet and the V-shaped valleys range from 30-2,550 feet from a depth of 50-250 fathoms below the sea-level.

The first series, consisting of four hill-like projections and two big and five small V-shaped valleys, covers a distance of about 18 nautical miles. One of the hill-like projections is 1.85 nautical miles wide whereas one of the two big V-shaped valleys is 2,550 feet deep and approximately 2½ nautical miles wide. This is followed by a flat but a deeply inclining shelf, giving rise to the second series which consists of four hill-like projections, and five V-shaped valleys. One of the flat-topped, steep-sided hills is 1.65 nautical miles wide and 2,400 feet high.

Several theories have been put forward regarding the origin of submarine canyons. They are attributed to diastrophism, faulting, erosion during a vast lowering of sea-level, and action of turbidity currents especially during Pleistocene times (Kuenen, 1938; Dietz, 1953). But, in recent years, most of the theories have been discredited, 'leaving only the turbidity current hypothesis and another which combines subaerial erosion with drowning and maintenance of the canyons by turbidity currents, submarine slides, and sand flows' (Shepard, 1963, p. 337).

However, a detailed investigation of these canyons is necessary before their exact relationship to the continental shelf could be explained.

Particular thanks are due to Dr. N. K. Panikkar, Director, Indian Programme, International Indian Ocean Expedition, for providing the writer an opportunity to participate in the 15th Scientific Cruise of INS KISTNA and to

Commander Maitra and ships officers for their assistance.

M. G. ANANTHA PADMANABHA SETTY.  
Indian Ocean Physical  
Oceanographic Centre,  
Ernakulam (India), September 25, 1964.

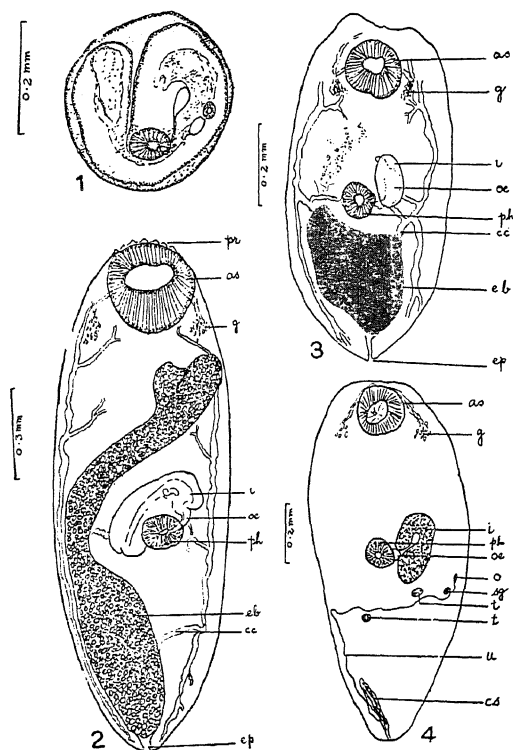
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## OBSERVATIONS ON A GASTEROSTOME METACERCARIA FROM BAGARIUS BAGARIUS

A GREAT variety of fish, both inland and marine, have been reported as hosts of a number of representative forms belonging to the trematode family *Bucephalidae* Poche, 1907 (*Gasterostomata* Odhner, 1905). Verma (1936, 1936 a), Bhalerao (1937), Srivastava (1938), Chauhan (1943), Dayal (1948) and Gupta (1956) have described Indian species, occurring in the intestine, under such genera as: *Bucephalus* Baer, 1826; *Rhipidocotyle* Diesing, 1858; *Neidhartia* Negaty, 1937; *Neoprosorhynchus* Dayal, 1948; *Prosorhynchus* Odhner, 1905; *Bucephalopsis* (Diesing, 1855) and *Neobucephalopsis* (Dayal, 1948). The fresh-water fishes recorded as hosts of this commonly occurring group of digenetic trematodes are:—*Macrones seengala*, *M. aoria*, *Belone strongylina*, *B. concila*, *B. garuai*, *Pangasius buchani*, *Silundia gangetica*, *Eutropiichthys vacha*, *Pseudotropius garua* and *Bagarius yarrelli*—all carnivorous species. The bucephalid trematodes, mostly parasitic in fishes and sometime in amphibians also, have furcocercus cercaria with mussels and some of the fishes acting as second intermediate hosts. As far as could be ascertained, the metacercaria of this group do not seem to have so far been recorded or described from India.

In three of the five specimens of *Bagarius bagarius*, available locally for collection of its parasitic fauna, the musculature revealed a heavy infestation with small whitish thin-walled cysts of 0.3-0.51 mm. in diameter with a black-pigmented area in the centre, the bodies being more numerous in the regions of the trunk (Fig. 1). After teasing of the cysts, the worm lying folded upon itself was extracted and showed an extensive excretory bladder full of dark contents and occupying the major part of the body. A prominent sucker at one end with a group of hypodermal glands situated behind and representing the fundamentals of vitellaria were the other features (Fig. 2).

A number of specimens, after extraction, were studied alive in normal saline in which a few were also left for more than eight hours with a view to have the details of morphology, particularly of the excretory system, brought out more clearly. Some were also fixed in 10% formalin and Bouin's fluid for making stained permanent preparations.



FIGS. 1-4. Fig. 1. A cyst. Fig. 2. Living worm, freshly taken out from the cyst. Fig. 3. Living worm (entire), kept for 8 hours in saline. Fig. 4. Stained preparation. as, oral sucker/rhynchus; cc, collecting canal; cs, cirrus sac; eb, excretory bladder; ep, excretory pore; g, anterior gland mass; i, intestine; oe, oesophagus; ov, ovary; ph, pharynx; pr, anterior prominences; sg, shell gland mass; te, testis; u, uterus.)

The actively motile worms with an elongated body, a broader anterior end and a narrower posterior part, measured  $0.83-1.38 \times 0.41-0.65$  mm. in size, exhibited the characteristic anterior sucker/rhynchus of circular outline, subterminal in position, and 0.21 mm. in diameter. The anterior margin of the body carried seven prominent papilla-like prominences. The pharynx, near the middle of the body and 0.06-0.10 mm. in diameter opened, through a thick-walled oesophagus, into the

sac-shaped intestine. The intestinal region exhibited a dark character because of the presence of excretory material. The tubular and vesicular excretory bladder extended anteriorly beyond the mouth with its pore at the posterior tip. In specimens left over in saline the extent of the bladder was found to have decreased as it extended anteriorly to near the posterior limits of the intestine. The characteristic collecting canals with their main branches, one on each side and draining their contents into the bladder, reached forward to near the anterior sucker/rhynchus (Fig. 3). Rudiments of genitalia, i.e., two testes, ovary and shell gland mass, situated in the posterior half, with the cirrus sac and the terminal part of the uterus passing backwards to the posterior end were all visible, the genital pore being sub-terminal (Fig. 4).

Yamaguti (1958) recognised under Bucephalidae, five subfamilies on the character of excretory bladder, whether tubular or Y-shaped; the position of ovary in relation to testes; and the character of anterior sucker/rhynchus, whether sucker-like, plug-like, funnel-shaped or wedge-shaped. Relying on this classification, the present form is assigned to the genus *Bucephalus* of the subfamily Bucephalinae Nicoll, 1914 because of the sucker-like rhynchus having seven tenticular appendages, position of pharynx and ovary, and presence of a tubular excretory bladder. Correct systematic determination, however, is only possible when the adult stage of this metacercaria is recovered from experimental studies. The metacercarial forms, so far known from freshwater fishes, mostly relate to the clinostomatids and strigeids. The present finding of a bucephalid metacercaria is evidently a first report of natural infection from India.

Department of Parasitology,  
U.P. College of Veterinary

B. P. PANDE.  
P. RAI.

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# EFFECT OF BLUE-GREEN ALGAE IN COMBINATION WITH UREA ON RICE YIELD

THE efficacy of blue-green algae in increasing rice yield under different treatments has been reported in earlier communications.<sup>1-5</sup> In this note, the rôle of blue-green algae in combination with urea, a fertilizer for rice, is reported.

Urea was applied at 10 and 20 kg.-N/ha. as soil application at transplanting and as foliar application 50 days after transplantation. Blue-green algae, consisting of *Nostoc sphaericum*, *N. amplissimum*, *Tolypothrix campylonemoides* and *Westiella* sp. were applied at transplanting. A basal dressing consisting of 500 kg. lime + superphosphate @ 20 kg. P<sub>2</sub>O<sub>5</sub> + 0.28 kg. sodium molybdate per hectare was applied to each pot before planting the seedlings. This pot culture experiment in three replications was conducted during the main crop season of 1963 (July-December). A popular rice variety T 141 was used as test crop.

Data of grain and straw yield, ear-bearing tillers and length of panicles, are presented in Table I. As the plants of two pots were found to belong to a different variety, they were rejected and, hence, a statistical analysis of the data was not done.

(13.5% over check). The overall increases of grain and straw recorded by algal treatments over non-algal treatments were of the order of 103.6% and 97.7% respectively. Urea at 10 and 20 kg.-N/ha. produced comparatively lower responses than blue-green algae.

Soil application of urea indicates a higher response than when applied as foliar spray.

Urea in combination with blue-green algae generally produced additional response in the instance of soil application. The response in combination with foliar spray was inferior.

The present study further confirms the beneficial rôle of blue-green algae in increasing rice yields and in some respects its superiority.

The authors thank Dr. R. H. Richharia, Director, for his keen interest in this work; Dr. R. Subrahmanyam, Botanist, for supplying algal material from his cultures and guidance in the work and in the preparation of this account; and Sri. S. Parnaik, Agricultural Chemist, for valuable help in the course of the work.

Division of Blue-Green Algae, L. L. RELWANI.  
Central Rice Res. Inst., G. B. MANNA.  
Cuttack, Orissa,  
August 6, 1964.

TABLE I  
Effect of blue-green algae in combination with urea (1963 Main crop)  
(Gm. per pot. Average of 3 replications)

Treatment	Average yield per pot (gm.)				No. of ear-bearing tillers per pot		Average length of panicle	
	Grain		Straw					
	A	B	A	B	A	B	A	B
Check (No treatment)	5.23 (160)	10.90 (209.0)	3.83 (100)	8.00 (208.9)	3.70 (100)	5.30 (143.2)	16.93 (100)	113.5 (113.5)
Urea @ 10 kg. N/ha. (Soil application)	6.27 (119.9)	*12.7 (242.5)	4.91 (128.2)	9.10 (237.6)	3.30 (89.2)	6.00 (162.2)	18.17 (107.3)	19.42 (114.7)
Urea @ 20 kg. N/ha. (Soil application)	8.66 (165.6)	14.43 (275.9)	6.33 (165.3)	11.80 (308.1)	5.00 (135.1)	8.00 (216.2)	18.32 (108.2)	17.95 (106)
Urea @ 10 kg. N/ha (Foliar application)	5.73 (109.6)	*11.53 (220.5)	4.27 (111.5)	9.20 (240.2)	3.30 (89.2)	6.50 (173.7)	17.87 (105.6)	17.63 (104.1)
Urea @ 20 kg. N/ha. (Foliar application)	4.90 (93.7)	13.03 (249.1)	4.77 (124.5)	9.55 (249.3)	3.50 (89.2)	6.00 (162.2)	18.28 (108.0)	19.13 (113.0)
Mean	6.16 (117.8)	12.54 (239.8)	4.82 (125.8)	9.53 (248.8)	3.73 (100.8)	6.36 (171.9)	17.91 (105.8)	18.67 (110.3)

A—Without blue-green algae; B—with blue-green algae.  
Figures in brackets represent treatment rating with check as 100.

\* Varietal mixture was observed in these pots.

It may be observed that application of blue-green algae alone to check pot accounted for 109.0% and 108.9% increase of yield of grain and straw respectively. These increases resulted from a higher number of ear-bearing tillers (43% over check) and greater length of panicles

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## TWO NEW VARIETIES OF *GEORGEFISCHERIA RIVEAE*

COLLECTIONS of malformed shoots of *Argyreia cuneata* Ker. Gawl., a member of the Convolvulaceae, were made by Narasimhan in 1916 in Magadi near Bangalore. A reference to its witches broom-like appearance simulating Spike disease of Sandal was made by Coleman.<sup>2</sup> Recent collections, made in Katraj, near Poona, show diseased symptoms identical to those observed in Mysore.

The diseased shoots were transformed into witches brooms and in a way resembled those of *Rivea hippocrateriformis* Choisy, on which the smut genus *Georgefischeria* was previously described by Narasimhan *et al.*<sup>1</sup> Detailed microscopic examination revealed that the malformation was incited by a species of *Georgefischeria*. The malformed shoots contained within the vascular bundles and mesophyll tissues, large lysigenous cavities containing spore masses embedded in gelatinous matrix. Mature spores, when teased out and placed for germination in water, developed promycelia with apical whorls of 3 to 4 sporidia as in *G. riveae* Thirum. and Narasimhan, the type of the genus. Mature chlamydospores were globose to polygonal, hyaline to pale yellow, smooth, measuring 8.5 to 13  $\mu$  with a mean of 10.5  $\mu$ .

Detailed morphological and cultural studies on *Georgefischeria riveae* and the two new varieties reported in this preliminary note are being published separately. The fungus on *Argyreia cuneata* differs from *G. riveae* in having slightly smaller spores and thinner wall layers (0.7  $\mu$  as compared with 1.5 to 2  $\mu$  in *G. riveae*). It is proposed to present it as a new variety under the name *G. riveae* var. *argyreia* var. nov.

*Georgefischeria riveae* THIRUM. AND NARASIMHAN  
VAR. *argyreia* VAR. NOV.

Infection systemic, sori in the leaves and stem, inciting malformation of the axillary shoots, appearing like witches brooms; sori appearing superficially as pale yellow patches; in sections of leaves and shoots large lysigenous cavities occupying the space between the epidermis and within the vascular bundles. Sori irregular, formed by coalescing of lysigenous cavities and containing numerous spores embedded in gelatinous matrix secreted by the hyphae lining the sorus. Mature spores globose to polygonal, hyaline or pale yellow, 8.5 to 13  $\mu$  with a mean of 10.5  $\mu$ , germinating by a promycelium bearing at the apex a cluster of 3 to 4 sporidia.

Hab. in Leaves and Shoots of *Argyreia cuneata* Ker. Gawl., Katraj, Poona.

Since reporting *G. riveae*, several collections of witches brooms from different places in Maharashtra were made and studied. A large-spored form, which constituted a new variety, was obtained from Aundh area. The type of symptoms produced and the morphology of the spores are identical with that of *G. riveae*. The name *G. riveae* Thirum. and Narasimhan var. *macrospora* var. nov. is proposed. Table I gives a comparative account of the spore measurements of *G. riveae* and the two new varieties.

TABLE I

Species	Range of spore measurements	Frequency of the spores of different dimensions per 100 spores							Mean value
<i>G. riveae</i>	9-17 $\mu$	9 $\mu$	11 $\mu$	13 $\mu$	15 $\mu$	16 $\mu$	17 $\mu$		13.5 $\mu$
		8	4	32	24	29	3		
<i>G. riveae</i> var. <i>macrospora</i>	14-18 $\mu$	14 $\mu$	15.5 $\mu$	17 $\mu$	18 $\mu$				16.5 $\mu$
		14	30	32	24				
<i>G. riveae</i> var. <i>argyreia</i>	8.5-13 $\mu$	8.5 $\mu$	10 $\mu$	11 $\mu$	12 $\mu$	13 $\mu$			10.5 $\mu$
		8	42	24	14	12			

Pimpri, Poona,  
October 14, 1964.

M. J. NARASIMHAN.  
M. J. THIRUMALACHAR.  
M. C. SRINIVASAN.

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## REPORT ON A COLLECTION OF BITING MIDGES (DIPTERA : CERATOPOGONIDAE) FROM A SUBURB OF CALCUTTA

The present note refers briefly to a population of biting midges collected between last week of November and mid-December, 1963, either by sticky trap or by rearing the imagoes out of the immature forms inhabiting the available muddy environs and the rotting banana plants in Haringhata farm under the University of Kalyani, about 35 miles to the north of Calcutta. The collection comprised several genera of which specific identity has only been possible in the midges belonging to the genus *Culicoides* on the basis of the key by Sen and Das Gupta,<sup>1</sup> and partly the genus *Dasyhelea* also. Some of the midges belonging to the other genera recorded from the area appear to be new in relation to the species known so far from this

part of India.<sup>2</sup> A comprehensive account covering all such cases will be dealt in another communication in due course and below are enlisted those so far identified.

*Forcipomyia* GROUP

1. Genus *Atrichopogon* Kieffer.—1 female by sticky trap; 1 species.

2. Genus *Forcipomyia* Meigen.—2 females and 2 males, by sticky trap and larval rearing out of mud; 2 species.

*Dasyhelea* GROUP

3. Genus *Dasyhelea* Kieffer.—136 females and 90 males, by sticky trap and larval rearing out of rotting banana mass; 4 species, those identified being as follows:

(i) *D. longicornis* Kieffer, *Rec. Indian Mus.*, 1913, 9, 180. Known in female from coastal area of Puri so far, this is now collected in 45 females and 46 males both by sticky trap as well as by rearing from rotting banana stump. Distinctive in it are: yellowish scutum in thorax shows dorsad 4 dark brown longitudinal bands with 2 at middle closely placed in the anterior half while others are laterad; haltere knob pale, cream-coloured in fresh state; legs yellowish with stray brown spots at middle of all femora and tibiae with a hind tibial comb of 7 spines; male genitalia include two separated parameres hooked at tip, ninth sternite with a very wide caudo-median depression and basistyle without any visible internal roots.

(ii) *D. ornaticornis* Kieffer, *Rec. Indian Mus.*, 1913, 9, 180. Known in female from Katihar (Bihar) so far, this is now collected in 52 females and 28 males both by sticky trap as well as by rearing from rotting banana stump. Distinctive in it are: brownish scutum in thorax shows dorsad 3 chocolate-coloured longitudinal bands; haltere knob pale, whitish in fresh state; legs yellowish with stray brownish marks at middle of all femora and tibiae with a hind tibial comb of 6 spines; male genitalia include parameres as fused into one piece, ninth sternite with a depressed caudal margin and basistyle as in the previous species while dististyle bifid.

*Culicoides* GROUP

4. Genus *Culicoides* Latreille.—10 females and 7 males, by sticky trap and larval rearing out of mud; 2 species as follows:

(i) *C. schultzei* (End.), Carter, Ingram and Macfie, *Ann. Trop. Med. and Parasit.*, 1920, 14, 231, figs.—A very widely known Afro-Asian species, with previous records from different localities in the districts of Midnapore, Birbhum, Howrah and 24-Parganas in West Bengal. Also known from south and west of Indian peninsula. Its distribution ranges from West Africa to Japan. Now collected in 7 females and 7 males both by sticky trap as well as by larval rearing out of mud.

(ii) *C. similis* Carter, Ingram and Macfie, *Ann. Trop. Med. and Parasit.*, 1920, 14, 255, figs.—Another Afro-Asian species, originally described from Gold Coast (Africa) but much less known with only a few Indian records so far from west and east peninsular India and in West Bengal from localities in Midnapore, Howrah and 24-Parganas;<sup>1,3-5</sup> this is now collected in 3 females only both by sticky trap as well as by larval rearing out of mud.

*Ceratopogon* GROUP

5. Genus *Alluaudomyia* Kieffer.—1 female, by sticky trap; 1 species.

*Stilobezzia* GROUP

6. Genus *Stilobezzia* Kieffer.—2 females, by sticky trap and by larval rearing out of mud; 1 species as follows:

(i) *S. spirogyrae* Carter, Ingram and Macfie, *Ann. Trop. Med. and Parasit.*, 1921, 14, 325, figs.—Originally known in both sexes from Gold Coast (Africa) and was recorded for the first time in India from environs of Calcutta<sup>6</sup>; this is now collected as above.

*Comments.*—The present study shows the prevalence of 11 distinguishable species, with the identity of 5 species only established now, belonging to 6 genera of 3 principal subfamilies of biting midges at Haringhata (Nadia: West Bengal) for the first time. Besides reporting on such little known genus in India as *Alluaudomyia*, the study confirms the occurrence of the African *Stilobezzia*, *S. spirogyrae* in the country. It also shows the natural breeding site of 2 very important *Dasyhelea*, viz., *D. longicornis* and *D. ornaticornis*, and brings to light their diagnostic features from both sexes known so far in female only. It is found that the *Dasyhelea* species under reference breed in the rotting banana stumps left after felling the

plants. Presence of a very limited number of *Culicoides* specimens in comparison to those of the other genera in the collection now made although striking, nonetheless, not unusual as it has noticed before also that a population decline of *Culicoides* occurs in Gangetic West Bengal at the approach of cold season.<sup>7</sup>

P. SEN.\*

August 10, 1964.

S. K. DAS GUPTA.†

\* Entomology Department, University of Kalyani, Kalyani (Nadia: W. Bengal).

† Zoology Department, Presidency College, Calcutta.

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### INFLUENCE OF MICRONUTRIENT STATUS ON THE METABOLISM OF AMINO-ACIDS IN CITRUS LEMON SEEDLINGS

In recent years, much information has been gathered to indicate the effect of nutritional disorders on the spectra of free amino-acids present in the leaves. Most of the work relate to such studies in annual plants and the topic was reviewed by Hewitt.<sup>3</sup> The present study was projected for the identification of the free amino-acids present in citrus leaves under the conditions of deficiencies as well as excess of boron, copper, manganese and molybdenum.

Seedlings of citrus (var. rough lemon) were raised in Hoagland's culture solution, following the technique described earlier by Ved Parkash and Saxena.<sup>9</sup> The treatments were initiated

when the seedlings were 45 days old, and on appearance of the symptoms characterised to each deficiency or excess (reported earlier by Ved Parkash and Pushpalata<sup>8</sup> and Ved Parkash and Subiah<sup>10</sup>), the affected leaves were analysed for the spectra of free amino-acids present, adopting ascending chromatographic technique suggested by Block *et al.*<sup>1</sup> Known standards were run for necessary comparison and Rf values calculated. The intensity of spots was categorised into low (+), medium (++) or high (+++), visually.

The results on the spectra of free amino-acids present in various samples are given in Table I.

It is seen that seedlings raised under the deficiency conditions had fewer amino-acids present and the concentrations of those present were either increased or curtailed. The excess levels of the micronutrients, enhanced the accumulation of the amino-acids. However, the deficiency or excess of each element produced a different pattern as can be inferred from Table I.

Amino-acids are known to participate in various pathways and any disturbance in their spectra could result in metabolic drifts leading to suppressed plant growth associated with the symptoms of malnutrition. The present study reveals that molybdenum deficiency leads to overall reduction in the amino-acid content, while the reverse pattern was noticed in Mo-excess cultures. This appears to be in conformity with the role of molybdenum in nitrate reduction in plants and is corroborated with the findings of the workers elsewhere.<sup>4-7</sup>

Finally such an investigation relating to the effect of micro-elements on the spectra of the amino-acids present in the leaves would reveal of their interactions, which might provide a basis for the identification and assessment of the nutritional disorders.

TABLE I  
Free amino-acids present

Amino-acid Rf at 20°C.	Cystine 0.04	Aspartic acid 0.09	Serine/ glycine 0.13	Gluta- mine 0.18	Alanine 0.23	Proline 0.27	Methio- nine 0.49	Phenyl alanine 0.63
(i) Control	.. ++	++	+	++	+	++	+	+
(ii) Seedlings raised in deficiency of :								
Boron	.. 0	++	0	++	++	++	0	0
Copper	.. 0	++	+	++	++	++	+	++
Manganese	.. ++	++	+	+	+	++	+	+
Molybdenum	.. 0	+	0	+	0	+	0	0
(iii) Seedlings raised in excess of :								
Boron	.. +++	++	+	+++	++	++	+	++
Copper	.. +++	++	+	+++	++	++	+	+
Manganese	.. +++	++	+	+++	++	++	+	+
Molybdenum	.. +++	++	+	++	++	++	+	+

+ Present; 0 Absent.



The authors are indebted to Dr. M. S. Swarninathan and Professor R. D. Asana for constant encouragement during the progress of work.

Division of Botany, VED PARKASH.  
Indian Agric. Res. Inst., S. N. BHARDWAJ.  
New Delhi-12, July 27, 1964. (MISS) PUSHPALATA.

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# RECORD OF HEXAMERMIS SP. (A NEMATODE) ON SOME SPECIES OF MOTH BORERS OF SUGARCANE IN INDIA

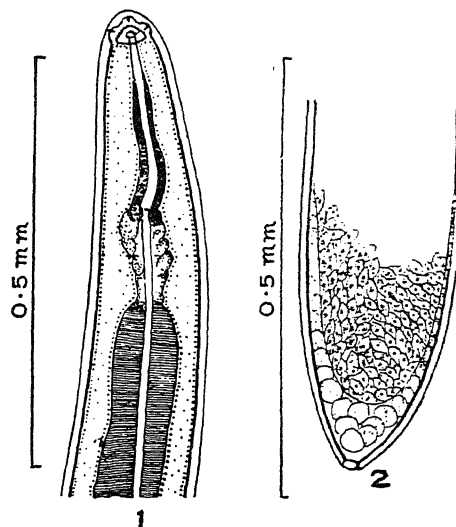
VARIOUS workers have recorded nematodes on different species of moth borers of sugarcane in India. Ali (1957) observed *Mermis* sp. on the shoot borer, *Chilo traea infuscatellus* Snell. at Pusa in Bihar; David (1962) recorded *Neotylenchus* sp. on a caterpillar of top borer, *Scirpophaga nivella* F. at Koothanallur in Madras State. Gupta (unpublished) observed *Hexameris* sp. on a caterpillar of stalk borer, *Chilo traea auricilia* Ddgn. (1957), and Chaudhary (unpublished) on top borer, *S. nivella* (1961), at the Indian Institute of Sugarcane Research, Lucknow.

The present author, in the course of his studies at the Indian Institute of Sugarcane Research, Lucknow, during 1962-63 came across nematodes in the hæmocœle of caterpillars of the sugarcane stalk borer, *C. auricilia* and shoot borer, *C. infuscatellus* (July, 1962), top borer, *S. nivella* (July, 1963) and the internode borer, *Proceras indicus* Kapur (August, 1963). In one caterpillar of *C. auricilia* (August, 1963), the nematode was recorded in association with the larval parasite, *Apanteles flavipes* Cam. (Braconidæ—Hymenoptera). The species of nematode was the same in all cases and was

identified as *Hexameris* sp. (Mermithoidea—Nematoda), by Dr. H. E. Welch of Canada.

This species of nematode was usually found in the hæmocœle of the host caterpillar and appeared to be damaging the viscera and the fat bodies within the host. In one case the nematode was observed partially outside the body of a caterpillar also; the caterpillar concerned did not show any further development and died 6 days after. In another case (August, 1963), the nematode was found moving in the borer tunnel within the cane-stalk at a height of about 100 cm. from the ground level.

The last instar of this species of nematode is creamy white in colour and has a tapering proximal and a blunt distal end. It measures 135 mm. in length and 0.295 mm. in breadth. The mouth leads directly to the pharynx (Fig. 1) which is long and tenuous reaching almost half the body length. It has a dorylaimoid styt, with knobs at (proximal) spear ends. The buccal capsule is conspicuous by its absence. The anus is present at the extreme posterior end (Fig. 2).



FIGS. 1-2. Last instar of juvenile stage of *Hexameris* sp.

The author is indebted to Dr. H. E. Welch, Entomology Research Institute, Ontario, Canada, for kindly identifying the nematode, and to Shri A. N. Kalra for his guidance in the course of these studies.

Indian Institute of  
Sugarcane Research,  
Lucknow-2, July 4, 1964.

R. C. SRIVASTAVA.

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## REVIEWS

**The Cell**, Vol. VI. *Biochemistry, Physiology, Morphology*. Edited by Jean Brachet and Alfred E. Mirsky. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xiv + 564. Price \$18.00.

*The Cell* is a co-operative work issued as a series of volumes and has been devoted to modern knowledge of the biology, biochemistry, biophysics, structure, and function of cells. So far five volumes have been issued. Volume I dealt with Methods and Problems of Cell Biology, Volume II dealt with Cells and Their Component Parts, Volume III dealt with Meiosis and Mitosis, Volumes IV and V dealt with Specialized Cells. The reception given to these volumes have encouraged the authors and publishers to issue a supplementary volume reflecting recent discoveries concerning ultra-structure and biochemical activity.

The first four chapters of the present volume deal with the cells of lower organisms, while the last two are concerned with the highly specialized structures in higher organisms. The following are the subjects dealt with in the individual chapters and the names of their respective contributors: (1) The Protozoan Nucleus, by Karl G. Grell; (2) The Cytoplasm of Protozoa, by William Trager; (3) The Fungi, by John B. Raper and Karl Esser; (4) The Plant Cell: Aspects of its Form and Function, by Bruce R. Voeller with Electron Micrographs, by Myron C. Ledbetter and Keith R. Porter; (5) Sensory Cells, by R. Cordier; and (6) Connective Tissue Cells, by Sylvia Fitton Jackson.

Though described as a supplementary volume, the book under review may be considered to be a treatise in itself. The subjects are dealt with in a very attractive fashion and the volume is beautifully illustrated. It is assured of an enthusiastic welcome. C. V. R.

**Advances in Lipid Research**, Vol. I. Edited by Rodolfo Paoletti and David Kritchevsky. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xii + 418. Price \$14.00.

This is the first volume of a new series which is intended to serve as an instrument for stimulating progress within the broad area of lipid research and the contributors will be recognized authorities in the various subclassifications within the field. This series has been started

under the editorship of Rodolfo Paoletti and David Kritchevsky.

The material covered in the first volume of this series ranges from chemical and physico-chemical discussions of the structure and behaviour of lipids through one of the newer areas in lipid research, sulfolipids. The most recent work on fat absorption and transport is presented by experts in the various special phases of this work. Other chapters cover the latest developments in cholesterol metabolism, vitamin E as it affects lipid metabolism, and a treatment on atherosclerosis. All areas of lipid research ranging from physical chemistry to physiology and pathology are touched upon.

The following contributions appear in the volume under review: I. The Structural Investigation of Natural Fats, by M. H. Coleman; II. Physical Structure and Behaviour of Lipids and Lipid Enzymes, by A. D. Bangham; III. Recent Developments in the Mechanism of Fat Absorption, by John M. Johnston; IV. The Clearing Factor Lipase and Its Action in the Transport of Fatty Acids between the Blood and the Tissues, by D. S. Robinson; V. Vitamin E and Lipid Metabolism, by Roslyn B. Alfin-Slater and Rosemary Shull Morris; VI. Atherosclerosis—Spontaneous and Induced, by Thomas B. Clarkson; VII. Chromatographic Investigations in Fatty Acid Biosynthesis, by M. Pascaud; VIII. Carnitine and Its Role in Fatty Acid Metabolism, by Irving B. Fritz; IX. Present Status of Research on Catabolism and Excretion of Cholesterol, by Henry Danielsson; X. The Plant Sulfolipid, by A. A. Benson. C. V. R.

**Physiological Mammalogy**, Vol. I. *Mammalian Populations*. Edited by William Mayer and Richard Van Gelder. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1964. Pp. xii + 381. Price \$12.00.

The treatise under review was conceived with a view to bring together the existing knowledge of an experimental nature on those animals usually regarded as "wild". Hitherto, experimentation in animal biology has been largely oriented around the dog, cat, rabbit, mouse, guinea pig, and white rat. Despite this concentration of effort, over the years numerous researchers have investigated the use of different animals for experimental purposes. The

writings of these investigators, however, are scattered widely. The basic idea of the preparation of "Physiological Mammalogy" has been to make available to the experimental biologist the wealth of data contained in the work of these scientists.

The volume under review consists of two comprehensive articles dealing with the physiology of populations, viz., (1) The Social Use of Space, by John B. Calhoun and (2) Endocrine Adaptive Mechanisms and the Physiologic Regulation of Population Growth, by J. J. Christian. Calhoun's article, on "The Social Use of Space", presents many interesting new ideas on the behaviour of animals in populations and the effects of grouping of individuals upon the physiology of the organism. Where many workers have thought of the experimental animal only as an individual apparently divorced from his environment and other members of the species, Calhoun points out the fallacy of this view in providing experimental data that demonstrate the effects of numbers of individuals on the behaviour of each individual. The second article, by J. J. Christian, on population growth, treats the problem largely from an ecological view-point in dealing with limiting factors of natural populations and population interrelationships.

C. V. R.

**An Introduction to Genetics.** By A. H. Sturtevant and G. W. Beadle. (Dover Publications, Inc., 180, Varvick Street, New York-14), 1962. Pp. 391. Price \$ 2.00.

The present work by two of the world's leading biologists has long been regarded as a very thorough exposition of genetical analysis. Prepared on a broad survey of data, it has never been superseded for thoroughness and accuracy. The present work is a slightly corrected reprint of the 1939 edition and as it represents a very full coverage of genetics up to the year of its original publication, it should be very useful to students of the subject. The volume consists of the twenty-three chapters listed as follows: Sex Chromosomes; Sex-linkage; Autosomal Inheritance; Independent Assortment; Linkage; Chromosome Maps; Relation of Crossing Over to Meiosis; Intra-chromosomal Rearrangements: Inversions; Intra-chromosomal Rearrangements: Incomplete Chromosomes; Lethals; Translocations; Multiple Alleles; Mutations; Position Effect; Non-disjunction and Related Phenomena; The Determination and Differentiation of Sex; Overlapping Phenotypes, Selection, and Hybrid

Vigor; Heterogeneous Populations; Polyploidy; Species Differences; Extrachromosomal Inheritance and Maternal Influences; Genes and Phenotypes; Historical.

C. V. R.

**International Conference on Cosmic Rays: Proceedings of VIII Conference in Jaipur (Vol. 5). High Energy Interactions.** Pp. 595. Price Rs. 30.00. (For copies write to Secretary, I.C.C.R., Tata Institute of Fundamental Research, Bombay-5.)

Volume 4 on Extensive Air Showers, which was the first one to be published in this six-volume series reporting the Proceedings of the Eighth International Conference on Cosmic Rays, was reviewed earlier in this Journal (see *Curr. Sci.*, 1964, 33, August 5). The present Volume 5, the second to come out in the *Proceedings*, is on High Energy Interactions and contains 67 contributions from 134 authors. Most of the contributions are group contributions from various centres of work, and they cover a wide range theoretical, observational and instrumental, bringing out the latest (up to end of 1963) in cosmic ray physics. Discussions that took place are also given at the end of each paper presented. The Editorial Committee are to be congratulated in bringing out these volumes so speedily, which will be greatly appreciated by workers in this rapidly advancing field of research.

A. S. G.

**Advances in Textile Processing (Vol. 1).** Edited by J. Edward Lynn and J. J. Press. (Textile Book Publishers, Inc., New York), 1961. Pp. 379. Price \$ 14.00.

This book is the first of a projected series on *Advances in Textile Processing*. There are eleven chapters in the book all written by authors well known in their respective branches. In addition to the Textile Science and Technology, the series will cover operational research, quality control, mill management and organisation, etc. Thus, these volumes will make a good supplementary reading to the well-known *Review of Textile Progress* published every year by 'The Society of Dyers and Colourists' and 'The Textile Institute'.

The chapters on 'Non-woven Fabrics' and 'The Felting of Wool and the Manufacture of Wool Felt' are well written. Not much information on these subjects is readily available. The modern trend in Textile processing being resin finishing four chapters are devoted to this and related topics. A full essay is written on the 'Chlorine-Resistant Resins' which is a very

important branch in the field of application of synthetic resins to cotton. The chapter on the 'Evaluation of Wash and Wear' discusses the methods of test for Resin-finished cloth to keep up the quality. Hansen describes in 'The Neutral Scouring of Greasy Wools' the development of a practical, neutral process based on Alkyl Phenol type of non-ionic detergents which has been in use in U.S.A.

The chapters on 'Recent Developments in Wool Textile Processing', 'Water Oil and Grease Repellency' and 'Thermoplastic Resin Dispersions for Textile Finishing' enlarge the field of coverage of this book. The essay on 'Processes for Dyeing Hydrophobic Fibres with Disperse Dyes' is very well written and has covered the theoretical, practical and the machinery aspects of these processes.

The language, style and the approach to the subject are different in each chapter as they are written by different authors. The book will be very useful to all textile scientists and technologists.

C. V. R.

**Handbuch Der Kolorimetrie, Band II. Kolorimetrie in Der Pharmazie.** By E. Kakac and Z. J. Vejdelek. (Veb Gustav Fischer Verlag Jena), 1963. Pp. viii + 1128. Price D.M. 83.20.

While reviewing the Volume I of this series, it was observed that "we eagerly look forward to receive the other two volumes II and III brought out by Veb Gustav Fischer Verlag Jena". Volume II which is now put forward adequately meets the expectation in contents and presentation of the topics dealt with.

The descriptive methods for the photometric estimation of compounds treated in the present volume is the same as is found in the First Volume. The first part of the book (715 pages) deals with synthetic compounds under several sub-headings such as acyclic hydrocarbons including aliphatic halogen derivatives, oxy and oxo compounds, acids, esters, amides, amines and amine alcohols. The second unit in this section deals with isocyclic compounds including organo arsenic and mercury compounds. Under heterocyclic compounds, derivatives of oxygen, nitrogen and sulphur are systematically described under this section. The second part of the book (125 pages) deals with preparation of some organo compounds.

The third part (100 pages) is devoted to the examination of steroides and the fourth part contains a few methods for the estimation of inorganic anions such as chloride, bromide, sulphate, borate and nitrate.

The volume is complete with original references, author index, synonyms index and subject index. A small list of correction for the errors is also supplied along with the volume. As pointed out earlier, the volume under review is very valuable in any Pharmaceutical Laboratory and all the chemists and druggists remain grateful to the authors for presenting this valuable ready reference book. We shall now look forward to receive the third and the final volume in the series.

A. R. V.

**Nuclear Research Emulsions, Vol. I. Techniques and Theory.** By Walter H. Barkas. (Academic Press, New York and London), 1963. Pp. xvi + 518. Catalogue Price Rs. 90.00.

This book is a most valuable addition to the literature on the nuclear emulsion technique. The only other book in this field that the reviewer is aware of, in the English language, is the classic *Atlas of Photomicrographs* illustrating "The Study of Elementary Particles by the Photographic Method", by Powell, Fowler and Perkins. The splendid *Atlas*, printed on art paper, concerned itself with lofty heights: it aimed at giving in historical perspective the discoveries concerning elementary particles, heavy primaries and interactions at ultra-high energies, which all followed from applications of the photographic method; in that volume the authors wanted to convey to the reader the excitement associated with these discoveries. The *Atlas* was expensive and so to be found in the possession of libraries rather than individual workers. In his monograph Dr. Barkas has attempted a different task. He has produced a text-book which contains the "bread and butter" information needed by emulsion workers. All the required quantitative information is there and the essential theory underlying the methods of measurement and analysis.

He has dealt with the properties of emulsions, preparation of stacks for exposure, processing, imperfections in the processed emulsions, microscope and scanning techniques, measurements of scattering, ionization and range; even emulsion-making has found a place in an Appendix. These broad areas have been broken up further into the necessary detailed discussions on individual aspects as the continuously changing section headings at the top of each page show. He has painstakingly and critically evaluated the available observations and calculations, and knowing Dr. Barkas' reputation in this regard, I can assure the reader that the information presented in the book can be depended upon.

This is the sort of book I would have expected of Dr. Barkas and he has not disappointed me. The book is well produced and I have been unable to pick out errors. It is warmly recommended to all workers in the field. The review would be incomplete if I did not quote Dr. Barkas' advice on scanning (pages 212-213): "Music during work has been found good, especially if local control of loudness can be exercised, and if the type of music is chosen well. FM radio tuned to "music" stations has been found satisfactory. Rest periods such as coffee breaks are necessary for relaxation, but have been known to get out of hand when no scientist is working closely with the scanners". How true! The book is not as dry as its title might suggest!

M. G. K. MENON.

**Fluidised Particles.** By J. F. Davidson and D. Harrison. (Cambridge University Press, London, N.W. 1; India: Macmillan and Co., Madras-2), 1963. Pp. 155. Price 35 sh.

During the last twenty years enormous amount of literature has grown on fluidization which include three books (Leva, Othmer and Zenz-Othmer), several proceedings of symposia and a large number of papers. The fluidization operation has found application for a wide variety of purposes like petroleum processing, chemical reactions, metallurgical treatment, etc.

The present book is written by two active workers in the field and is well produced and gives a clear account of the theoretical background though biased towards their own models of fluidized beds.

The book is divided into six chapters. Chapter one deals briefly with the use of fluidized systems, range of fluidized state, incipient fluidizing velocity, expansion of a particularly fluidized bed and the two-phase theory of fluidization.

The second and the third chapters deal with the formation, rise and coalescence of bubbles in fluidized beds and its analogy with rise of bubbles in an inviscid liquid. In chapter four the exchange between the bubbles and particulate phase has been discussed. The stability of bubbles in fluidized beds and the fluidized bed as a catalyst reactor have been discussed in chapters five and six respectively.

The appendices, a bibliography index of authors and general index add to the value of the book.

The theoretical presentation is somewhat oversimplified and certain aspects of fluidized beds are not covered in the book. Neverthe-

less, the book is valuable to teachers and students of chemical engineering and for research workers in this field and designers of fluidized bed reactors.

N. R. KULOOR.

#### Books Received

From: (Academic Press, 111, Fifth Avenue, New York, 10003):

*Microwave Scanning Antennas*—Vol. I: *Aperatures*. Edited by R. C. Hansen, 1964. Pp. xvii + 442. Price \$16.00.

*The Bacteria—A Treatise on Structure and Function*—Vol. V: *Heredity*. Edited by I. C. Gunsalus and R. Y. Stanier, 1964. Pp. xvi + 517. Price \$16.00; Sub. \$14.00.

*Positronium Chemistry*. By J. Green and J. Lee, 1964. Pp. xii + 105. Price \$5.50.

*Recent Progress in Surface Science* (Vol. I). Edited by J. F. Danielli, K. G. A. Pankhurst and A. C. Riddiford, 1964. Pp. xii + 414. Price \$16.00.

*Electronic Aspects of Biochemistry*. Edited by B. Pullman, 1964. Pp. xiii + 582. Price \$20.00.

*Molecular Orbitals in Chemistry, Physics and Biology—A Tribute to R. S. Mulliken*. Edited by Per-olv Lowdin and B. Pullman, 1964. Pp. xiii + 578. Price \$22.00.

*Mammalian Protein Metabolism* (Vol. II). Edited by H. N. Munro and J. B. Allison, 1964. Pp. xv + 642. Price \$21.00.

*Nutrition—A Comprehensive Treatise*—Vol. I: *Macronutrients and Nutrient Elements*. Edited by G. H. Beaton and E. W. McHenry, 1964. Pp. xviii + 547. Price: Sub. \$16.60; Reg. 18.50.

*Differential Analysis* (Paper presented at the Bombay Colloquium, 1964). General Editor K. Chandrasekharan. (Oxford University Press, London E.C.-4), 1964. Pp. viii + 253. Price Rs. 25-00.

*Bacterial Endotoxins* (Proceedings of a Symposium held at the Institute of Microbiology of Rutgers). Edited by Maurice Landy and Werner Braun. (The Institute of Microbiology, Rutgers, The State University, New Brunswick, N.J.), 1964. Pp. xvi + 691. Price \$12.00.

*Treatise on Analytical Chemistry* (Part II)—*Analytical Chemistry of the Elements*. Edited by I. M. Kolthoff and P. J. Elving. (Interscience Pub., a division of John Wiley & Sons, Inc., New York; N.Y. 10016), 1964. Pp. xxii + 627. Price \$23.00.

*An Advanced Course in Practical Inorganic Chemistry*. By D. N. Grindley. (Butterworth & Co., 88, Kingsway, London W.C.-2); 1964. Pp. xv + 184. Price 17 sh. 6 d.

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## SCIENCE NOTES AND NEWS

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### Award of Research Degree

Osmania University has awarded the Ph.D. Degree in Geology to Shri Y. V. Ramana for his thesis entitled "Elastic Wave Velocities in Rocks".

### The Indian Society of Genetics and Plant Breeding

The Indian Society of Genetics and Plant Breeding is organizing an International Symposium on "The Impact of Mendelism on Agriculture, Biology and Medicine" to commemorate the Silver Jubilee Year of the Society and the Centenary Year of the publication of Mendel's paper, during 15th to 20th February 1965. Forty foreign and Indian scientists are expected to attend. Sessions include Mendelism and Evolution, Genetics in Plant Breeding (3 sessions), Cytology and Cytogenetics, Mutation, Human and Animal Genetics, Biochemical Genetics and Teaching of Genetics. Further details can be had from Dr. A. T. Natarajan, Secretary, Indian Society of Genetics and Plant Breeding, Division of Botany, Indian Agricultural Research Institute, New Delhi-12, India.

### Council of Scientific and Industrial Research, New Delhi, Annual Report 1963-64

The Annual Report of the C.S.I.R., New Delhi, for the year 1963-64 presents very briefly records of research carried out during the year at the various laboratories and organizations under its aegis, and also contains a resume of its activities with special reference to research co-ordination, sponsored research, survey and planning of research, international collaboration, publication and information, and national register.

The Report shows that during the year 652 research papers have been published, 72 patents filed, and 22 pilot plants set up.

### International Council of Scientific Unions (ICSU)

We have received the following publications of the ICSU: (1) *Bulletin No. 1*, May 1964 (64 pages) and (2) *The Year Book 1964* (150 pages).

The *ICSU Bulletin* contains preliminary reports of the tenth general assembly of the Council held in Vienna, 22-29 November 1963, and other news connected with the various scientific unions, national members, committees

and commissions. It also includes the calendar of meetings for the year 1964.

The *ICSU Year Book* gives lists of national and scientific members of the Council and membership of the ICSU Committees, Commissions, etc., statutes and rules of procedure, relations with other international organisations, and an alphabetical list of members and officers connected with the ICSU and its organisms.

### Inverse Fluorescence Effect

In ordinary fluorescence, either with ultra-violet, X- or gamma-rays a fluorescent substance absorbs radiation of higher energy and re-radiates part of it as less energetic radiation (Stokes Law). Research workers of the Signals Research and Development Establishment (SRDE), England, have been able to demonstrate the reverse effect using semiconductor crystals. Although the effect had been predicted, and also demonstrated, earlier, the technique involved the use of liquid helium temperatures. The present approach which uses a simple set-up and easy procedure shows possibilities of practical applications.

In the reported investigation a crystal of a semiconductor material doped with a rare earth is made to absorb longer wavelength (low energy) infra-red light and re-radiate shorter wavelength (high energy) visible light. The effect is accomplished by the crystal's property of adding the energy of two or more quanta of absorbed infra-red radiation and re-radiating the total energy. This property depends not only on the electron structure of the atoms of the doping material but also on the structure of the host crystal. To show the effect, the crystal is simply placed in a focused beam of infra-red radiation when it will glow.—(*New Scientist*, 1964, 21, 201.)

### Pathogenic Fungi and Bacteria : CMI Data Sheets Sets I and II

This new undertaking of the Commonwealth Mycological Institute to bring out at periodic intervals a series of loose-leaf sheets giving descriptions and illustrations of plant parasitic fungi and bacteria will be widely welcomed by plant pathologists and mycologists. The object of this series is to provide standard descriptions of pathogens for use by pathologists, particularly those isolated workers with restricted library facilities.

Set I deals with 10 rust fungi on coffee, maize, millet, mint, sorghum and sugarcane. Besides description, distribution, transmission, notes and literature each sheet contains photomicrographs showing details of spore morphology.

Set II deals with 10 plant parasitic bacteria : *Xanthomonas citri*, *X. malvacearum*, *X. sesami*, *X. albilineans*, *X. vesicatoria*, *Corynebacterium insidiosum*, *C. sepedonicum*, *C. michiganense*; *Pseudomonas solanacearum*, *P. sesami*.

Each set is priced 5 shillings and orders should be addressed to the Director, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey, England.

Plant and Soil Nematodes (Technical Bulletin No. 2, H. M. Stationery Office, London)

Laboratory Methods for Work with Plant and Soil Nematodes, the well-known Bulletin published by the Ministry of Agriculture, Fisheries and Food, London, is being used by nematologists throughout the world. The first edition was prepared by the late Dr. Tom Goodey in 1949, and the third revised edition by his son Dr. J. Basil Goodey in 1957. In recent years many of the methods have been modified and new methods have been developed. The new fourth edition which has been completely revised by the author reflects these changes. Special mention may be made of the sections on cultural techniques and assaying nematocides.

The Bulletin of 72 pages is obtainable from H.M. Stationery Office, London, for 8s. 6d. or 9s. with postage.

### Specular Reflection of Phonons

In a recent communication to the *Physical Review Letters* J. Fajans and C. Z. Rosen have described experiment in which specular reflection of phonons has been observed in superfluid helium at 0.33° K. The phonons are generated at a small carbon transmitter and travel along various directions in the experimental chamber without colliding with other phonons. Some phonons go directly to a concave fused quartz mirror where they are specularly reflected, and, when the mirror is sharply focused so that the small carbon receiver in the experiment is conjugate to the carbon transmitter, an enhanced signal 14 times greater than the unfocused phonon background signal is recorded. Thus, the phonons are directly 'manipulated' simply by means of a spherical mirror to form the heater image at the carbon detector. Care was taken to see that the observed enhancement of

the received signal was not due to the specular reflection of thermal waves.

The ability to focus and diffract phonons would make available a new method for studying phonon spectra of solids.—(*Phys. Rev. Letters*, 14 September 1964.)

### A New Fermium Isotope Fm<sup>257</sup>

Fermium (Fm) is a transuranic element of atomic number 100 and atomic weight [252]. Scientists of the Lawrence Radiation Laboratory of California University have identified a new fermium isotope which decays with a  $79 \pm 8$  day half-life predominantly by the emission of alpha particles of energy  $6.56 \pm 0.04$  MeV. This activity is assigned to mass 257. The spontaneous fission decay rate of Fm<sup>257</sup> is low, approximately  $2 \times 10^{-3}$  of its alpha decay rate.

Since Fm<sup>257</sup> is the heaviest nuclide produced thus far in a nuclear reactor, its stability is important relative to the question of producing even heavier nuclides through further neutron capture in reactors.

The Fm (257) is a product of a four-year neutron irradiation (total  $nvt = 4.1 \times 10^{22}$  n/cm.<sup>2</sup>) in the Materials Testing Reactor, Idaho, of a target consisting of a mixture of Pu (242), Am (243) and Cm (244) totalling about 1.5 gm. The Fm (257) is formed by neutron capture of species with mass 256, expected to be predominantly Fm (256) with some Es (256) (Einsteinium) present. It is expected that only a small fraction estimated at few hundredths of a per cent., of the total atoms of mass 256 are transformed to Fm (257), the remainder are lost to further heavy element formation by the spontaneous fission of 2.7-hour Fm (256).—(*Phys. Rev. Letters*, 7 September 1964.)

### Angular-Momentum Distribution in the Disks of Spiral Galaxies

F. Hoyle and D. J. Crampin report their findings on the angular-momentum distribution of eight galaxies based on the rotational velocity curves of Burbidge *et al.* In all cases the distributions are identical with accuracy better than 1% to the angular momentum distribution of a uniformly rotating, uniform spheroid, except in the central regions where the observational data are rather uncertain.

The results support the following conclusions: (a) that the galaxies in question condensed from uniformly rotating, uniform clouds; (b) that during the condensation process there was little turbulent mixing within the main mass material.—(*Astrophys. Jour.*, 1964, 140, 99.)

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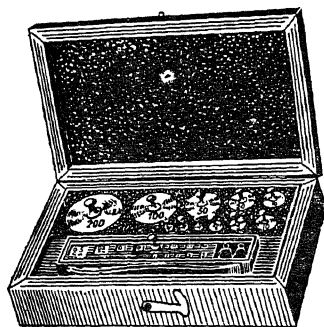
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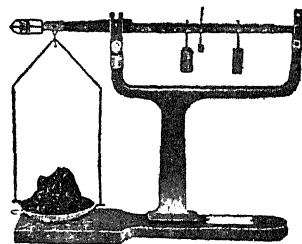
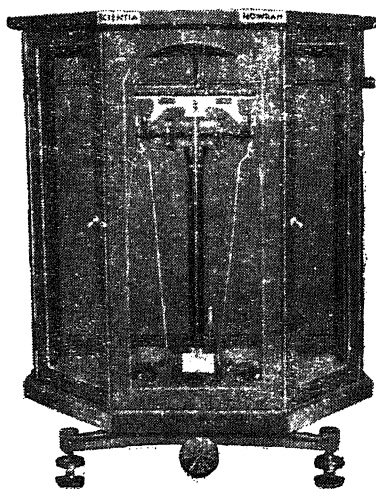
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# THE NEW PHYSIOLOGY OF VISION

## Chapter VI. Vision in Dim Light

SIR C. V. RAMAN

THE results which emerged from the investigations set forth in the three preceding chapters are evidently of a far-reaching character. They indicate fresh lines of approach to the basic problems which confront us in the physiology of vision. In the present chapter, we shall make use of some of the findings to elucidate the nature and origin of the differences between visual sensations at low and at high levels of illumination. We may begin by mentioning some facts of observation which indicate that there is a real difference in the visual processes operating at those levels.

When an observer who has been out-of-doors enters a dimly-lit room, his first feeling is that of finding himself in complete darkness. After a few minutes, however, he begins to perceive the most brightly illuminated objects in the room; later, those which are less bright come into view, one after another. The effect of a prolonged stay in complete darkness is even more striking; the sensitivity of the eye to feeble light is thereby enormously enhanced. *Per contra*, even a short stay in brightly illuminated surroundings suffices to destroy the sensitivity thus generated. We have, as it were, a process of "switching on" of the apparatus which enables the eye to function in dim light. There is also a "switching-off" of that apparatus which results from exposure of the eye to bright light and this is a fairly rapid process.

*Chromatic Sensations in Dim Light.*—Remarkable changes in our ability to perceive colour follow as a result of lowering the level of illumination of the objects under view. This effect may be exhibited in the following manner. A set of five steel plates of the same size may be painted over with enamels of brilliant hues and set side by side in the following order: White, blue, green, yellow and red. The observations may be made in a room which has been darkened and into which skylight can be admitted through a circular window provided with an iris-diaphragm of which the opening can be altered as desired from a diameter of 25 centimeters down to 5 millimetres. The illumination of the plates under view can thus be altered over a ratio of 2500 : 1.

As the iris is progressively closed down, very striking changes are noticed in the appearance of the set of plates. The plate which is red and exhibits that hue brilliantly when the iris is fully open becomes darker and darker as the illumination is diminished by closing down the iris. The plate then turns black and remains completely black. This, of course, is the well-known Purkinje phenomenon. A perfect contrast with the behaviour of the red plate is provided by the plate which is white. This exhibits no change whatever and remains throughout as the brightest of all the plates. The brilliant colours shown by the yellow, green and blue plates become much less brilliant as the iris is progressively closed down. At low levels of illumination, the yellow plate continues to exhibit that hue but much enfeebled. It also appears more luminous than the other two plates but is inferior to the white plate in that respect. Next in order of brightness is the green plate which continues to exhibit a greenish hue. The blue plate appears in the same circumstances to be of a darker hue with a bluish tinge.

*The Colour-Luminosity Relationship.*—The changes in chromatic sensations manifested at low levels of illumination have in the past been sought to be explained on the basis of an assumed duality of the human retina, *viz.*, a day-retina which perceives colour and a night-retina which has only colourless vision; in the day-retina the cones are the receptors of vision, while in the night-retina, the rods perform that function. That this approach to the theory of colour perception cannot be sustained is evident from the facts of observation recalled in an article by the author entitled "Stars, Nebulae and the Physiology of Vision" published in the issue of *Current Science* dated the 20th of May 1964. When we look at the sky by night and fix our attention on any particular star, its image is formed on the foveal region of the retina, and since this contains only cones and no rods, it is cone-vision and not rod-vision that is functioning. The effective surface-temperatures of the stars show a great range of variation. Nevertheless, it is a fact of observation that the vast majority of the stars visible to the naked eye appear merely as specks of light without

any hint of colour. But as seen through a telescope with an objective of adequate size and correspondingly great light-gathering power, the colours of the individual stars and the differences between them are much more evident. Then again, the gaseous nebulae, *e.g.*, the Great Nebula in Orion, as seen through small telescopes, appears as areas of diffuse luminosity without noticeable colour. On the other hand, as viewed through giant telescopes, they exhibit brilliant and variegated hues. It is thus clear that the factor which determines the observability of colour is the magnitude of the light-flux which reaches the eye of the observer. Hence also, a distinction between rod-vision and cone-vision is irrelevant in this context. In the fifth chapter of this treatise, observations have already been described showing that a change in the level of the illumination of the object under view profoundly influences the chromatic sensations which it excites, thus affording an experimental confirmation of the same result as that emerging from the visual observations in the field of astronomy referred to above.

*The Colours of the Spectrum.*—A technique has been devised by the author for a critical study of the chromatic sensations excited by a pure spectrum at all levels of illumination. It is both simple and flexible and yields results free from all uncertainty or possibility of error. The observer places himself in a large room which can be completely darkened and in which there are no source of light present which can disturb or distract his vision. The light under observation enters the room from outside through a long narrow opening of which the actual width can be varied within wide limits. Such an opening is readily provided by a suitable adjustment of the wooden shutters which cover one or another of the windows of the room. The observer sits facing the opening at some considerable distance from it and holds close to his eye a diffraction grating of good quality, as for instance, one of the replica gratings supplied by the firm of Adam Hilger in London. The observer's field of vision then includes, besides the opening itself, the diffraction spectra of various orders on either side of it. The spectral resolution provided by the grating is such that even with these simple arrangements a great many Fraunhofer lines can be seen in the spectra. If the observer is sufficiently far away from the window, the opening between its shutters can be increased by a ratio of 100 : 1 without any serious loss of purity in the spectra, while their brightness is increased in that ratio. Still

larger variations in the light-flux can be obtained by merely choosing the time of the day at which the observations are made. The light of the sky which enters through the opening has practically zero intensity on a dark moonless night. It is much brighter when the sky is lit up by the light of the moon. In daytime when the sun is well above the horizon, it is enormously brighter. During the hours of twilight, before dawn or after sunset, it exhibits a progressive increase or a progressive diminution, as the case may be. The observer is thereby enabled without using any special equipment to study the chromatic sensations excited by the rays of the spectrum at all levels of illumination, ranging from zero upwards to high values.

*The Results of the Study.*—The diffraction spectra seen when the light of the sun-lit sky is admitted through the opening between the shutters are of the usual type in which the luminosity of the red region of the spectrum is conspicuously greater than that of the blue region. Simple inspection enables the observer to discover for himself some very significant results. For example, with the particular grating employed, the first-order spectrum on one side is very bright and the second-order spectrum on the same side is very weak. Comparison of the two spectra shows that the visible difference in their luminosities goes hand in hand with a notable difference in their chromaticities. This difference is exhibited by every part of the spectrum ranging from the red end to the violet. But the blue-violet regions in the two spectra which are the least luminous show the difference in a particularly striking fashion. Likewise, a diminution in chromaticity can be observed at all points in the spectra of all orders when the illumination is lowered by a large reduction in the width of the opening through which the light is admitted. The variations in chromaticity as between the spectra of different orders are particularly conspicuous when the observations are made early in the morning or late in the evening when the light-flux reaching the eye of the observer is rather low.

The spectra as seen under "dim-light" conditions—*e.g.*, at night time using the moon-lit sky—present a totally different appearance. They are much shortened, the red region being totally absent. The first-order spectra exhibit a greenish hue for the greater part, while their terminations on either side exhibit slightly different hues. The second-order spectra on

either side which are of much lower intensity can be seen but do not exhibit any recognisable colour.

The change in the character of the spectra in passing from high-level to low-level illumination can be followed by making the observations during twilight hours. The changes from one type of spectrum to the other can also be quickly effected and observed by the use of two polaroids between which the diffraction grating is interposed. If the polaroids are in the crossed position, the spectra are completely cut off. By rotating one polaroid with respect to the other, the light is restored and the progressive increase in the brightness of the red region relatively to the rest of the spectrum can be readily followed.

We may sum up the results of the observations as follows. At the higher levels of illumination, the chromaticity of the spectrum colours is profoundly influenced by the magnitude of the light-flux which reaches the eye, falling off rapidly as the light-flux diminishes. This effect is exhibited by all parts of every spectrum. At low levels of illumination, the red end of the spectrum is cut off, as is to be expected in view of the Purkinje phenomenon. But the other spectrum colours continue to be observable even at such levels, though in an attenuated form, their chromaticity decreasing progressively as the level of illumination is lowered.

*Observations with Colour Filters.*—The studies described in the preceding chapter and in the present one may be usefully supplemented by the aid of colour filters suitably chosen and judiciously employed. The most suitable filters are those which transmit restricted regions of the spectrum and effectively cut off the rest. If such a filter is interposed between the eye of the observer and a diffraction grating in the method of observation described earlier, the overlap of the spectra of higher orders with each other is effectively avoided and it becomes possible for the observer directly to compare with each other the spectra of all the orders. Four or five orders are exhibited on each side by the replica grating, their intensities falling off with increasing order. The fall in chromaticity which goes hand in hand with the decrease in luminosity is then very strikingly exhibited. As all the spectra can be seen simultaneously, this is a highly impressive demonstration of the fact that colour and luminosity are inseparable

aspects of our visual sensations and have to be considered together in physiological theory. Four filters suitable for observations of this kind have been used, one transmitting a band at the violet end of the spectrum, the second a band in the blue, the third a band in the green, while the fourth transmitted the red region in its entirety and cut out the rest of the spectrum. All the four filters exhibit the stated effects in a very striking fashion.

If a colour filter be held in front of an observer's eye and a white surface under daylight illumination is viewed through the filter, the appearance of the surface depends greatly on the actual level of such illumination. These variations can be demonstrated in an impressive fashion by making the observations in a darkened room, the illumination being controlled by the use of a circular window covered by an iris diaphragm, as has been described earlier. The observer should view alternately the window through which the light is admitted into the room and the surface on which the light falls, holding the filter in front of his eye all the time. A striking difference is then observed between the chromatic effects noticed in the two cases. As the iris is progressively shut down, the window as seen through the iris continues to exhibit the same brightness and the same brilliant colour throughout. On the other hand, the chromatic sensation excited by the illuminated surface progressively becomes weaker and weaker and approximates more and more nearly to an achromatic sensation as the iris is shut down.

Finally, mention should be made here of a remarkable effect noticed in observations of the same nature as that mentioned above when a red filter is held in front of the observer's eye and the object viewed under daylight illumination is itself an object of a brilliant red colour, e.g., a plastic sheet of that colour, or a steel plate covered with red enamel. By reason of the Purkinje effect, the surface under observation would appear black if its illumination by daylight is below a certain level. If, however, the illumination is a little above that level, it would continue to be visible, but would exhibit a dark red colour. In these circumstances, the effect of interposing a red filter before the observer's eye and then removing it is a dramatic change in its appearance. Without the filter, the surface appears dark red; as seen through the filter, it seems almost perfectly white.



Ghosh<sup>21</sup> gives the Cretaceous succession at Therriaghat as shown in Table I.

TABLE I

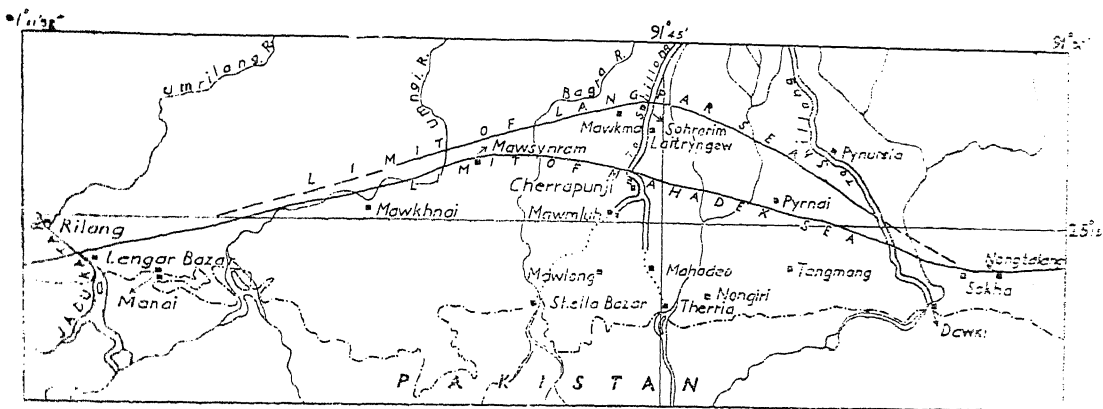
Langpar Stage	3.	Impure earthy and sandy limestone
	2.	Calcareous shale
	1.	Mudstone
Mahadek Stage	3.	Soft, massive, gritty sandstone ocherous and highly fossiliferous at top
	2.	Arkose
	1.	Conglomerate

As early as 1900-01, Bose<sup>22</sup> gave the maximum thickness of the lower division as not less than 700 feet and that of the Upper as about 400 feet. According to Krishnan<sup>23</sup> the lower division is 770 feet and the upper 305 feet. From his recent mapping of the area just north of Mahadek, Bagchi<sup>24</sup> estimates a thickness of 1,500 feet for the lower division and 500 feet for the upper from the junction of the Arkose with the underlying Sylhet Trap to the unconformity below the Cherra sandstone.

TABLE II

Coal-bearing Cherra sandstone (Unconformity)	213 m.
Lime stone	12-18 m.
Sandstone	9-15 m.
Conglomerate (Unconformity)	15 m.
Sylhet Trap (Unconformity)	15 m.
Granite	..

The limestone contains such characteristic fossils as *Exogyra* cf. *suborbuculate* Lam, *Cardium* cf. *pilatum* Stol. forms which are found in the Niniyur Stage of the Cretaceous in South India.<sup>26</sup> No fossils were obtained from the underlying sandstone but apparently it belongs to the same stage being similar in composition to those occurring in the stage at Mahadek and Mawsynram. Further north at Mawksa (91° 43' 15" E.: 25° 20' N.) the limestone is exposed but still further north in the gorge of the Umlong no limestone is exposed. At a place north of Sohrarim (91° 45' 40" E.: 25° 22' 30" N.)



Map of Mahadek and Langpar Sea in Assam

From the nature of the rocks and the fossil contents, it appears that the Cretaceous exposures in the Jadukata gorge, Mawkhnai, Thangkrang, Laitsohphlang, Sohka, Jaintiapur Road, Nongjiri, the Wamanhill and the Devil's Bridge, all belong to the Mahadek Stage. The fossils collected from the exposure about two miles NE of Dawki also indicate the Mahadek Stage but the host rock differs being an argillaceous limestone. The upper stage appears to have been denuded away. However, at Therriaghat, Mawsynram and Thangkrang-Mahadek both the stages are exposed.

At Laitryngew the upper stage alone is exposed as the following section<sup>25</sup> (Table II) measured in the gorge of the Umstew near Fall 1023 feet (91° 44' 15" E.: 25° 19' N.) shows,

the Cherra sandstone is seen lying over an unconformity on a conglomerate, which is considered to belong to the Langpar Stage as the conglomerate is diachronous. The Langpar Stage is thus seen to overstep the Mahadek Stage.

The Mahadek Stage does not appear to have extended north of Cherrapunjee as in the sections examined in the river gorges north no member of the stage is identified.

The fact that the Mahadek Stage about 1,500 feet thick at Mahadek dies out north of Cherrapunjee and that the Langpar Stage 500 feet thick at the same place thins down to only 160 feet at Laitryngew, 8 miles away, indicates that the sea transgressed over a highly shelving shore.

In the following, the literature on this subject has been made to be as complete as possible during the Mahabaleshwar Conference.

1. Medliott, H. P., *Ann. Bot.*, 1909, 7.
2. La Touche, L. D. H., *Ann. Bot.*, 1909, 16, 1910, 1887, 20, 41.
3. Smith, E. H., *Bot. Rev.*, 1938, 28, 41.
4. Palmer, R. W., *Bot. Rev.*, 1938, 50, 1.
5. Evans, P., *Ann. Bot.*, 1931, 24, 109.
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10. Easter, E. H., *Bot. Rev.*, 1959, 2, 1264.
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## IN VITRO CULTURE OF EMBRYO SEGMENTS OF *CAJANUS CAJAN* MILLER

K. SUMIYAMA

Department of Botany, Kyoto University

**A**LTHOUGH much work has been concerned with the culture of young embryo, reports on the culture of embryo segments are fragmentary (Johri and Bajaj, 1963; Narayanaswamy, 1964; Sen and Verma, 1963; also see Allsopp, 1963). Interest in such work is twofold: (a) the rearing of many seedlings from a single hybrid embryo; and (b) a study of morphogenesis in the seedling. The embryo is also an excellent material for the study of the primary meristems. Here we have a situation where the root and shoot meristems of the plant are initiated rather close to each other from an undifferentiated mass of cells. Furthermore, the production of shoots in the axils of the cotyledons is worth exploiting in the field of experimental embryology.

The mature seed of *Cajanus cajan* is oval, buminous and contains an embryo consisting of two massive green cotyledons and a radicle-plumule axis. In the axils of the cotyledons there are undifferentiated shoot buds, each represented by a mound of cells. The work was designed to bring out the possibilities of rearing the excised shoot and radicle segments to maturity after the removal of the cotyledons.

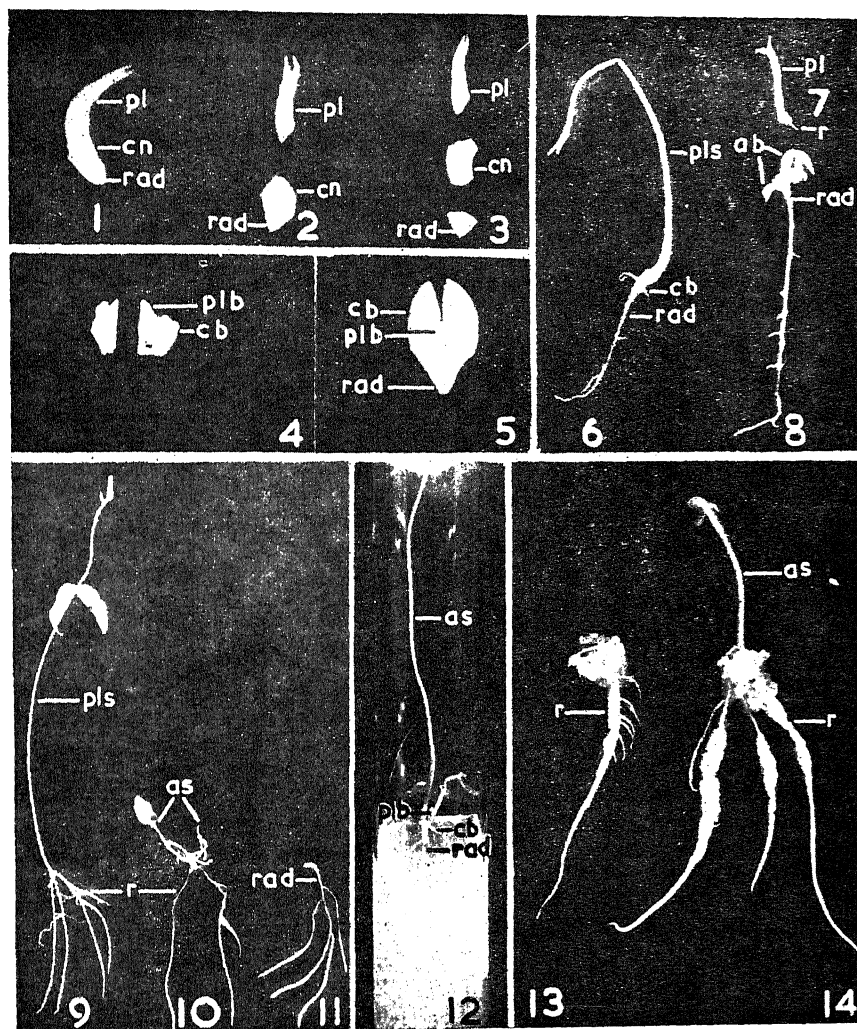
The decotylated embryonal axes were cut into two or three portions (Figs. 1 to 3) and the segments planted on Nitsch's basal medium (Nitsch, 1951). The basal medium was also supplemented with various growth factors: casein hydrolysate (200, 400, 500 ppm); coconut milk (100 and 200 ppm); kinetin (0.5 and 1 ppm);

gibberellins (10 and 20 ppm); indoleacetic acid (10 and 20 ppm); and indolebutyric acid (10 and 20 ppm). The explants were cultured in the dark at 25°C. The explants were examined at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

shoots and roots. The explants were examined at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

ening and coiling of the base of the epicotyl. When the medium was supplemented with 2,4-D or coconut milk, the cotyledonary node and the radicle callused. The nature of the callus differed in the two supplements. In 2,4-D the radicle did not elongate so that after callusing it assumed a top-like appearance, while in coconut milk the radicle elongated and

the activity of the cortical cells ruptured the epidermis at several places to expose the loosely arranged cells of the cortex and the enclosed stele. Lateral roots were produced in abundance in coconut milk and were thicker than the ones produced in the basal medium alone or in the medium supplemented with casein hydrolysate. In 2,4-D no lateral roots were produced in the



FIGS. 1-14. Culture of fragments of decorticated embryos. Figs. 1-5. Stages of inoculation. Figs. 6-14. Growth of embryonal segments *in vitro*. Fig. 1. Entire decorticated embryonal axis. Fig. 2. Radicle-plumule axis cut transversely just above the cotyledonary node. Fig. 3. Radicle-plumule axis cut transversely just above and below the cotyledonary node. Fig. 4. Cotyledonary node split into two portions. Fig. 5. Thin slice of radicle-plumule axis, cut longitudinally. Fig. 6. Ten-day-old seedling obtained from entire radicle-plumule axis (in Nitsch's basal medium). Figs. 7-8. Ten-day-old seedlings from the two parts (upper and lower respectively) of a single radicle-plumule axis cut as in Fig. 2. Figs. 9-11. 30-day-old seedlings resulting from a single radicle-plumule axis cut into three parts (upper, middle and lower) as in Fig. 3. Fig. 12. 19-day old culture showing seedling from a thin slice of radicle-plumule axis represented in Fig. 5. Figs. 13-14. 19 day old cultures of axillary buds on basal medium supplemented with 200 ppm coconut milk. Note profuse callusing. In Fig. 13 axillary shoot is obscure due to its coiling nature. (ab, axillary bud; as, axillary shoot; cb, cotyledonary base; cn, cotyledonary node; pl, plumule; plb, plumular base; pls, plumular shoot; r, root; rad, radicle.)

beginning but in two-month-old cultures short, lateral roots could be seen.

In cultures of entire decotylated axes the axillary buds were usually activated in 12 days after planting. The time was short when segmented embryonal axes were cultured as in experiments 2 and 3 (6 days) and experiment 5 (3 days). If the radicle-plumule axis was cut transversely into two parts just above the cotyledonary node and both the pieces cultured in the same tube, the cut end of the plumule produced one or more roots (Fig. 7). The radicle of the second segment produced roots and one or both of the axillary bud primordia were activated (Fig. 8). Thus, in this experiment two independent plantlets were established out of a single embryonal axis.

The growth reaction of the plumule to different media differed from that of the radicle. The plumule developed a callus at the free cut end in 2,4-D and coconut milk. Further, the cut end of the cotyledonary node as well as the radicle callused in the second segment.

The axillary bud primordia were activated in the second set of experiments only six days after planting; often a number of accessory buds were produced lateral to the axillary shoots. In the third set of experiments the radicle-plumule axis was segmented into three parts by two transverse cuts—one just above the cotyledonary node and the other just below it. The epicotyl produced roots at the cut end (Fig. 9) when the cotyledonary node regenerated a median root at the basal end resembling the original radicle or produced a number of roots from the cut end and one or two shoots by the activation of the axillary bud primordia (Fig. 10). Thus, two independent plantlets were established. The excised radicle produced only roots and no shoots showing that it is incapable of regenerating shoots (Fig. 11).

To activate the two axillary bud primordia for establishing independent plants, the cotyledonary node was longitudinally segmented so as to separate the two axillary bud primordia (Fig. 4) and both pieces were planted on the same medium. Each piece regenerated roots and the axillary buds developed into shoots (Figs. 13, 14). Thus, one embryonal axis formed three independent plantlets—one from the plumule and two from the axillary buds.

The fifth set of experiments involved thin longitudinal sections (3 or 4 cells thick) of the embryonal axis, containing the initials of root procambium, the little mounds of axillary bud

primordia and slices of cotyledonary bases (Fig. 5). In three days both the axillary buds were activated on the medium supplemented with casein hydrolysate (500 ppm) but with coconut milk (200 ppm) the activation was delayed until 6 days after culture. The section of the radicle regenerated into a complete rounded root and the plumular base also rounded up (Fig. 12).

It is concluded from the foregoing observations that in the growth of an isolated apical meristem in culture media the responses of the radicle, the plumule and the cotyledonary node are not identical. It is likely that the phenomenon of apical dominance prevails even in the embryonal stages; for when the axis is grown intact, the axillary buds do not develop quickly whereas they shoot up within three days when the plumule is separated and the other associated tissues are reduced to a minimum. It appears that the activation of the unorganized shoot apices, isolated from the axils of cotyledons, to form leafy shoots has been made possible for the first time on synthetic media. It was also possible to trace the differentiation of protoxylem and metaxylem in the segments isolated from the mature embryonal axis, with a view to understanding the developmental relationship between the primary xylem of the cotyledonary bundles and the primary root (the phenomenon of transition). The differentiation of the primary xylem takes place independently in the plumule (endarch), the cotyledonary node (transition), and the radicle (exarch). This happens even when the organs are isolated from each other prior to differentiation of vascular elements indicating that their destinies have already been determined.

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## LETTERS TO THE EDITOR

### DETERMINATION OF THE CO-ORDINATION NUMBER OF COBALT IN HYDRATED AND ANHYDROUS COBALT OXINATES BY X-RAY SPECTROSCOPY

VAN NORDSTRAND<sup>1,2</sup> has recently reported a large number of K absorption curves of transition metal ions in different types of compounds. According to him these curves could be classified in four distinct categories (see Sinha and Mande<sup>3</sup> for details). Of these, type IV curves, i.e., the curves for the tetrahedrally surrounded ions, alone show splitting in the principal K absorption edge. This splitting is explained by Sinha and Mande on the ligand field theory. Thus X-ray absorption spectroscopy provides a method of distinguishing between octahedral and tetrahedral surroundings of transition metal ions in complexes.

Merritt Jr.<sup>4</sup> has studied the structure of hydrated zinc oxinate by X-ray diffraction method. He reports that the co-ordination number of zinc is six in this compound. He also suggests that the zinc ion in anhydrous zinc oxinate should be tetrahedrally surrounded. The hydrous and anhydrous Cd, Pb, Co, Ni, and Cu oxinates are expected to be isomorphous with the zinc salts. Their structures have not yet been reported. The study of K X-ray absorption spectrum of hydrated cobalt oxinate  $[\text{Co}(\text{C}_9\text{H}_6\text{ON})_2 \cdot 2\text{H}_2\text{O}]$  and anhydrous cobalt oxinate  $[\text{Co}(\text{C}_9\text{H}_6\text{ON})_2]$  was undertaken, with the view of determining the co-ordination number of cobalt in these complexes.

A Cauchois type bent crystal X-ray spectrograph of diameter 49 cm., designed and constructed in the university workshop, was used in this investigation. The spectra were photographed using (100) reflecting planes of mica. Absorption screens were prepared by spreading uniformly finely powdered cobalt oxinate on cellophane adhesive tape. Microphotometer records of the spectra were obtained with magnification 50 on a Moll microphotometer.

Two representative microphotometer records of the cobalt K absorption edge in hydrated and anhydrous cobalt oxinates are shown in Figs. 1 and 2 respectively. The two curves closely resemble type I and type IV curves of Van Nordstrand. It should, however, be noted that the curves given by Van Nordstrand are

absorption coefficient *versus* energy curves, whereas our curves show the variation of transmitted intensity with energy. The curve of Fig. 1 shows a single K discontinuity while that of Fig. 2 shows the splitting of the principal

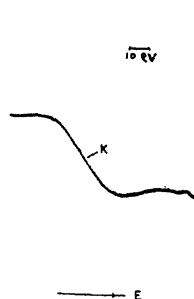


FIG. 1

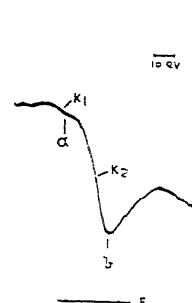


FIG. 2

FIGS. 1-2 show microphotometer traces of the Co K X-ray absorption edge in hydrous and anhydrous cobalt oxinates respectively obtained on a Moll microphotometer with magnification 50.

absorption edge into two components  $K_1$  and  $K_2$ . According to Sinha and Mande the minima at the markings 'a' and 'b' in Fig. 2, represent the X-ray absorption transitions  $1s \rightarrow 4p$  and  $1s \rightarrow p$  limit respectively. The forms of these discontinuities suggest that the cobalt ion is octahedrally surrounded in the hydrous complex, while in the anhydrous complex the surrounding of the ion is tetrahedral.

In cobalt oxinates the electronic configuration of  $\text{Co}^{++}$  ion is  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$ . Here the 3d orbitals are filled as the ligand field is weak. The tetrahedral arrangement is formed when four ligands are attached to the central cobalt ion, the possible hybridizations<sup>5</sup> being  $sp^3$  and  $d^3s$ . The latter seems more likely as the present X-ray investigation shows that the 4p orbitals are empty and localised to which the X-ray transition of the 1s electron is taking place. However, in hydrous cobalt oxinate, the structure being octahedral, there are six ligands around the cobalt ion (all weak field). The possible hybridization in this case is  $sp^3d^2$ . Our conclusions are in good agreement with the recent magnetic and ultraviolet absorption studies of Jatkar, Kulkarni and Mukhedkar.<sup>6</sup>

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Department of Physics, CHINTAMANI MANDE.  
University of Poona, A. R. CHETAL.  
Poona-7, September 14, 1964.

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### THERMAL BEHAVIOUR OF TETRAGONAL $\text{PbO}_2$ PHASE

THE tetragonal form of lead peroxide ( $\text{PbO}_2$ ), which has the rutile structure, can give off oxygen on heating, retaining the same structure, until the non-stoichiometric composition  $\text{PbO}_{1.875}$  is reached.<sup>1</sup> The loss of oxygen to form  $\text{PbO}_{1.875}$  creates about  $10^{21}$  oxygen vacancies per c.c. in the lattice. Since this number of vacancies is very large when compared to  $10^{18}$  per c.c. the order of vacancies that exist normally in a crystal at room temperature,<sup>2</sup> it is thought worth while to study the effect of the vacancies on the lattice parameters and the thermal expansion of the crystal. The present communication reports the preliminary results.

Using a Unicam 19 cm. high temperature powder camera, powder photographs of lead peroxide were taken at various temperatures ranging from 28° C. to 210° C. The  $\text{PbO}_2$  phase with rutile structure is found to be present only up to 210° C. Beyond this temperature, the structure undergoes a complete change to that of a lower oxide of lead. At each temperature, the cell parameters  $a$  and  $c$  have been evaluated using Cohen's analytical method as described earlier.<sup>3</sup> When the cell constants of the experimental specimen were again measured at room temperature, a slight increase in the cell constants was noticed. Hence, to examine whether similar changes would be observed at other temperatures, the cell constants were again determined at all the temperatures up to 210° C.

The cell parameters  $a$  and  $c$  at various temperatures are shown graphically in Figs. 1 and 2.

The cell parameters obtained in the first cycle (ABC) are shown by circles and those in the second cycle (DBC) by crosses. At the end of the second cycle, the cell constants at room temperature were once again determined and are shown by  $\Delta$  in the graphs.

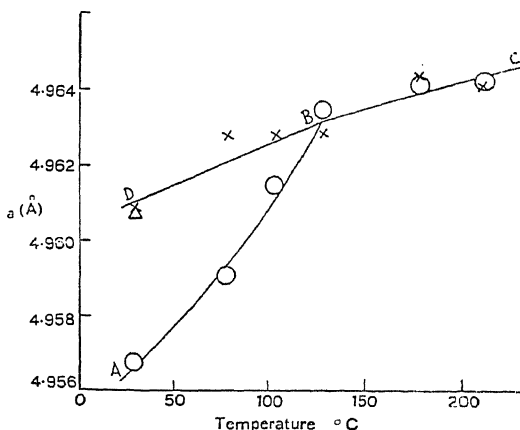


FIG. 1. Variation of  $a$  with temperature.

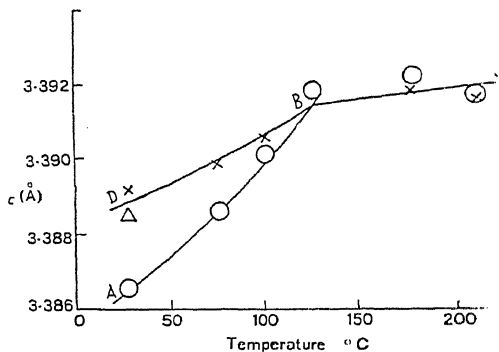


FIG. 2. Variation of  $c$  with temperature.

The differences, observed between the lattice constants at the same temperature in two cycles, may be explained as due to the oxygen vacancies created during the first cycle of heating. In ionic crystals, the effect of vacancies is a small expansion of the lattice.<sup>4</sup> Hence the lattice constants at room temperature after the first cycle of heating are slightly larger than those of the unheated sample. The thermal expansion for the region AB of the first cycle is larger than the corresponding region DB of the second cycle because, in the case of the unheated sample (first cycle), the expansion of the lattice due to the vacancies adds to the normal thermal expansion. The thermal expansion beyond B is almost the same in the two cycles. Probably, the effect of the vacancies on the lattice is more pronounced in the initial

stages and the lattice gets stabilised at the temperature corresponding to B.

It may be mentioned that the differences in the cell constants of  $\text{PbO}_2$  and reduced  $\text{PbO}_2$  observed in this investigation are much greater than the experimental error which is of the order of  $0.0004 \text{ \AA}$ . Hence the differences in the cell constants at the same temperature in the two cycles are quite real and show the effect of vacancies on the cell constants.

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Department of Physics, K. V. KRISHNA RAO.  
Osmania University, S. V. NAGENDER NAIDU.  
Hyderabad-7, October 6, 1964.

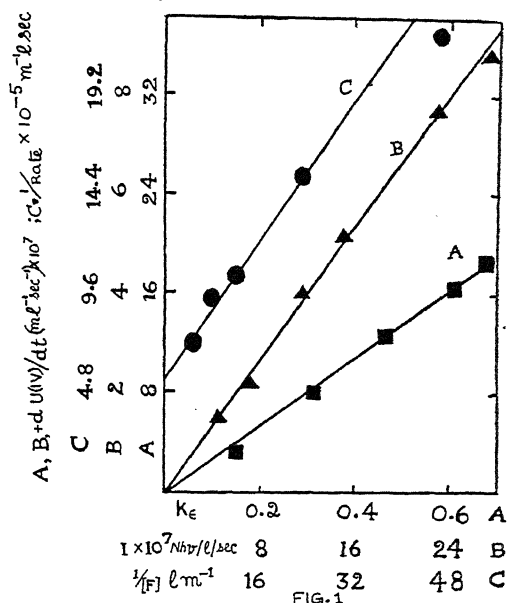
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# PHOTOCHEMICAL OXIDATION OF FORMALDEHYDE BY URANYL IONS $[\text{U(VI)}]$ IN AQUEOUS SOLUTION

STUDIES reported so far on photochemical oxidation of organic substrates by uranyl ions in aqueous solution have been few; and even here conflicting opinions have been expressed with regard to nature of primary photochemical act in these reactions.<sup>1-5</sup> We have undertaken a systematic study of oxidation of aliphatic and aromatic aldehydes and we report briefly our results with formaldehyde as the substrate.

Oxidation of formaldehyde F (0.02 M to 0.2 M) by uranyl perchlorate (0.01 M to 0.05 M) in perchloric acid medium by light of  $\lambda = 4350 \text{ \AA}$  (from a BTH 250-Watt high pressure mercury vapour lamp) under conditions of constant temperature ( $35^\circ \pm 0.01^\circ \text{C}$ ), ionic strength ( $\mu = 0.5$ ) and pH ( $< 2$ ) has been carried out. A specially designed cell with stopper containing the reaction system has been used both for irradiation purposes as well as for subsequent absorbancy measurements at  $670 \text{ m}\mu$  [for U(IV) production] in the Hilger-Watts H-700 Uvispek spectrophotometer. Formaldehyde in the system has been estimated from absorbancy at  $585 \text{ m}\mu$  of formaldehyde-chromotropic acid complex. Potassium ferrioxalate as well as uranyl oxalate actinometers have been used for determination of light intensities (I). The rate measurements [relating to U(IV) production] against variations in (a) light absorption fraction ( $k_e$ ) by U(VI),

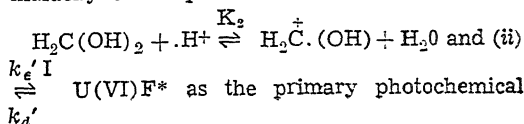
(b) formaldehyde concentration (F), (c) hydrogen-ion concentration ( $\text{H}^+$ ) have been followed and a rate equation established. Effects of temperature as well as ionic strength on rate have also been studied. We report briefly our results: (i) The dark reaction between  $\text{U(VI)} + \text{F}$  ( $35^\circ\text{--}80^\circ \text{C}$ ) is totally absent; (ii) undeaeated system on irradiation produces no U(IV); (iii) direct proportionality between (a) rate and light intensity (Fig. 1, B), (b) rate and  $k_e$  (Fig. 1, A); the net quantum yield for



U(IV) production remains constant at  $\sim 0.5$ , (c) reciprocal rate and reciprocal (F) (Fig. 1, C), (d) inverse proportionality between rate and ( $\text{H}^+$ ), (e) slight increase of rate with  $\mu$ , and (f) independence of rate with temperature. Effect of initially added U(IV) or formic acid (both are products of the reaction) which merited a thorough study could not be investigated because the former acts as an inner filter and the latter forms a complex with U(VI) complicating the kinetic features of the reaction.

We conclude that most of the observed kinetic features may be explained on the basis

of (i) a transient equilibrium  $\text{U(VI)} + \text{F} \xrightleftharpoons{K_1} \text{U(VI)} \cdots \text{F}$  and the equilibrium for the formaldehyde in aqueous solution:



and dark back reactions. The subsequent dark

reaction  $U(VI)F^* \xrightarrow{k_1} U(V) + H^+ + F^*$  ( $F^*$  = radical fragment from  $F$ ) is the rate determining step while reactions between  $U(VI) + F^*$ , disproportionation of  $U(V)$  to  $U(IV)$ , etc., are all fast. Assuming stationary state kinetics for  $[U(VI)F]^*$  and same extinction for  $U(VI)$  and  $U(VI)F$ , it has been deduced that:

$$\text{Rate} = \frac{k_1'}{1 + K_1 F_e}$$

when

$$k_1' = \frac{2k_1 k_e I}{(k_d' + k_1)}$$

$F_e$  = equilibrium  $F$

$k_e$  = light absorption fraction by  $U(VI)$  and  $U(VI) \cdots F$

and

$$\frac{1}{\text{Rate}} = \frac{1}{k_1'} + \frac{1 + K_2 (H^+)}{k_1' K_1 F_{\text{total}}}$$

From the plot of  $1/\text{rate}$  vs.  $1/F_{\text{total}}$ , the values of constants evaluated as a first approximation are:

$$k_1 = 0.4367; K_2 = 4.7 \text{ lm.}^{-1}$$

The postulate for formation of a transient photosensitive cluster is in accord with views of Heidt and Moon<sup>3</sup> and of Weigert<sup>6</sup> earlier. Total absence of dark reaction between  $U(VI)$  and  $F$  and absence of any absorption at 435  $m\mu$  by  $F$  and proportionality between  $1/\text{rate}$  and  $1/F$  indicates that excitation of  $U(VI)F$  is indeed the primary step. Absence of  $U(IV)$  in the underaerated irradiated systems suggests oxidation of  $U(V)$  to  $U(VI)$  by oxygen.

Dept. of Physical Chemistry, K. VENKATA RAO.  
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## OXIDATION OF RONGALITE WITH CHLORAMINE-T

It has been observed that chloramine-T brings about the oxidation of elemental sulphur<sup>1</sup> and its oxyanions.<sup>2,3</sup> The S—S links in a variety of sulphur compounds<sup>1,4</sup> can be ruptured and oxidised to sulphuric acid by this oxidant. The present investigations report on the oxidation of rongalite (sodium formaldehyde sulphonylate) in acid medium by chloramine-T and the results are compared with those obtained through an iodimetric titration of the sulphur compound.

Commercial rongalite was purified by repeated recrystallisation from an aqueous solution. The crystals obtained were of the composition  $NaHSO_2 \cdot HCHO \cdot 2H_2O$ . A solution of this salt was prepared in pure, freshly boiled and cooled distilled water. An approximately decinormal chloramine-T solution was standardised by the method of Bottger and Bottger.<sup>5</sup> Nearly decinormal iodine and sodium thiosulphate solutions were prepared from analar reagents and their strengths determined by standard methods.

**Procedure.**—An aliquot portion of rongalite solution was added to a known excess of acidified chloramine-T solution (10 ml. of chloramine-T with 20 ml. of 2N HCl) in a stoppered conical flask. The reaction mixture was shaken and set aside for half an hour. The excess of chloramine-T was then estimated by adding 10 ml. of 10% potassium iodide solution and titrating the liberated iodine against standard thiosulphate. A blank titration was carried out on the chloramine-T solution. From the titre values it was possible to calculate the number of equivalents of oxidant consumed by a mole of rongalite. The analytical values were found to be reproducible and the results of a few representative experiments are given in Table I.

TABLE I  
Oxidation of rongalite with chloramine-T

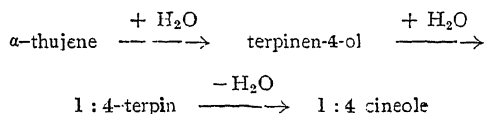
Expt. No.	Amount of rongalite taken $\times 10^5$ moles	No. of equivalents of oxidant consumed $\times 10^5$	No. of equivalents of oxidant per mole of rongalite	Oxidant
1	2.28	9.36	4.10	Chloramine-T
2	2.28	9.36	4.10	"
3	2.85	11.44	4.01	"
4	5.75	22.9	3.98	"
5	8.62	34.2	3.97	"
6	2.28	9.36	4.10	Iodine
7	5.75	22.9	3.98	"
8	5.75	23.4	4.07	"

It can be seen from the results of Table I that in acid medium, each mole of rongalite



primarily the isopropylidene derivative (V) in the p-series, which is in harmony with the scheme proposed by Lyubarskii<sup>6</sup> but contrary to what would be expected from the rule of Brown *et al.*<sup>7</sup>

The results of the action of phosphoric acid with  $\alpha$ -thujene, which has a cyclopropane ring in conjugation with an ethylene bond, were different from those obtained with I (Reaction 2). About 91% of II reacted with opening up of the incorporated ring to yield  $\alpha$ -terpinene (VIII),  $\gamma$ -terpinene (IX) and p-cymene (VI). The other possible isomer, viz.,  $\alpha$ -phellandrene was not detected. A significant finding was the formation of small amounts of 1:4-cineole (X). This oxide might have originated by the following sequence of reaction:



The difference in the reactivity of I and II is indeed astonishing, but can be accounted for as follows: In I, the cyclopropane ring has considerable stability by virtue of alkyl substitution<sup>8</sup> and, therefore, does not undergo easy cleavage under the influence of  $\text{H}^+$ . On the other hand, in II, the electron displacement in the double bond triggers the isomerization and causes the fission of the  $\text{C}_1\text{—C}_3$  bond which constitutes part of the incorporated ring.

Finally the transformations of d- $\alpha$ -pinene (III) and l- $\beta$ -pinene (IV) (Reactions 3 and 4) gave rise to the following common products: terpin hydrate (XI),  $\alpha$ -terpineol (XII), 1:8-cineole (XIII), dl-limonene (XIV), V, VI, VIII, o-cymene (XV); the  $\alpha$ -terpineol from III was dextro- and from IV laevorotatory. Unreacted III amounted to ~46%. Unlike III, IV reacted completely and afforded an additional isomer, l-limonene (XVI). Thus compared to III, IV is more reactive and this is in conformity with the behaviour of the compounds with exo-double bond to the 6-ring.<sup>7,9</sup>

This investigation therefore shows that the order of reactivity of the terpenes is as: IV > II > III > I.

The gift of  $\alpha$ -thujene from the Director, Museum of Applied Arts and Sciences, Sydney, is gratefully acknowledged. Thanks are also due to Prof. Rev. Fr. Lourdu M. Yeddanapalli, S.J. and Dr. N. S. Gnanapragasam, Department of Chemistry, Loyola College, Madras, for the infra-red spectra.

Department of Chemistry, K. K. SUGATHAN.\*  
Christian Medical College, JAMES VERGHESE.  
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\* Present address: Department of Chemistry, Sree Narayana College, Quilon.

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## ON THE EFFECT OF THE DISSOLVED GASES IN NUCLEATE BOILING

THE effect of the presence of the dissolved gases on the rate of nucleate boiling was investigated by different investigators<sup>1-3</sup> who studied the rate of heat transfer during boiling of tap-water, deaerated water and water saturated with air. It was a general observation that the heat transfer coefficient,  $h$ , increases with increase in gas content. It can be reasoned that the activation of nucleus at a particular superheat  $\Delta T$  will determine the heat transfer rate.

The boiling of the liquid starts only after the attainment of certain superheat  $\Delta T$  over  $T_0$ , where  $T_0$  is the boiling point corresponding to external pressure  $P_\infty$ . The superheat should be such that the pressure  $P$  inside the bubble should exceed the liquid pressure  $P_l$ , by an amount equivalent to the capillary pressure  $2\sigma/R$ , where  $\sigma$  is the surface tension and  $R$  is the radius of the bubble nucleus. Writing the integrated form of the Clausius-Clapeyron equation for one molecule, for small superheats

$$\frac{\Delta P}{T \Delta V} = \frac{\lambda'}{T \Delta V} \quad (1)$$

where  $\lambda'$  is the molecular latent heat of vaporisation. Assuming that the ideal gas law holds good and neglecting the volume of the liquid compared to the volume of vapour, we have

$$\Delta T = \frac{TV}{\lambda'} \cdot \frac{2\sigma}{R} \approx \frac{T_0 V}{\lambda'} \cdot \frac{2\sigma}{R} \quad (2)$$

Since  $V = kT_0/P$  where  $k$  is Boltzman's constant

$$\Delta T = \frac{2kT_0^2\sigma}{\lambda' P R} = \frac{2kT_0^2\sigma}{\lambda' R} \cdot A e^{\lambda'/kT_0} \quad (3)$$

If an inert dissolved gas is present in the liquid then

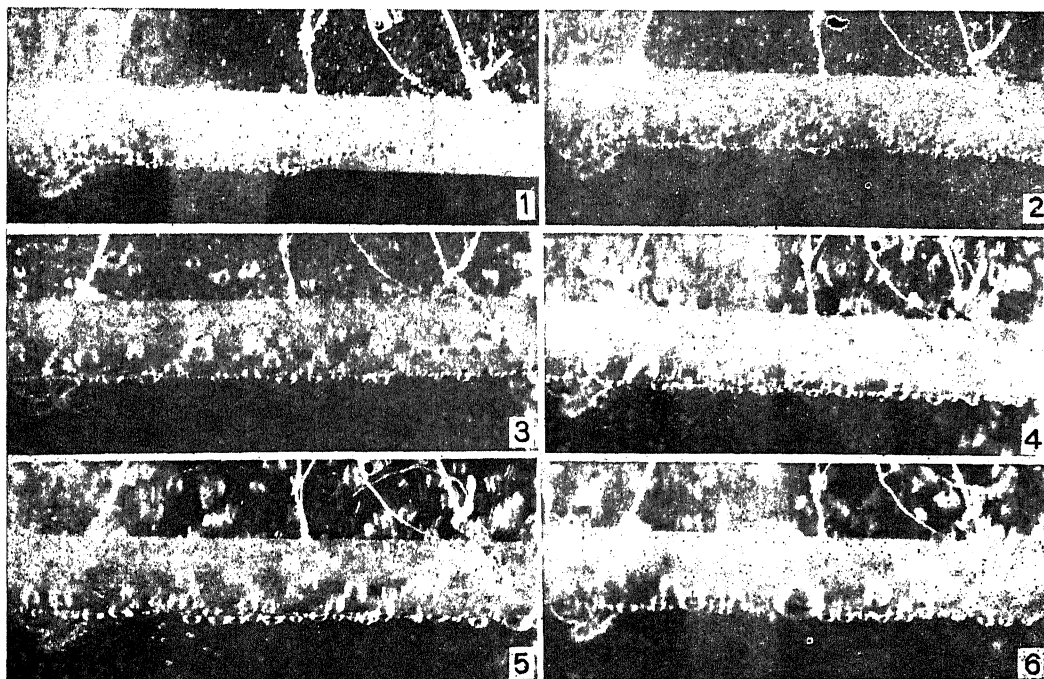
$$\Delta T = \frac{2kT_0^2\sigma}{\lambda' (P_l + P_g + P_v)_R} \quad (4)$$

where  $P_l$ ,  $P_g$ ,  $P_v$  are system pressure, partial pressure of gas and vapour respectively.

From equation (4), it is obvious that as the superheat increases the smaller size nuclei become active thereby increasing the number of nucleating sites and hence, the heat transfer coefficient. Also if the partial pressure of the inert gas is considerably high, the nuclei can be activated even at smaller  $\Delta T$ , than that required for liquids without any dissolved gases.

The above interesting factors can be observed in boiling of aerated water. A photographic study of such a behaviour at a low heat flux of 12,000 Btu/hr. ft.<sup>2</sup> and a temperature difference of 8.2° F. is shown in the series of Figs. 1-6. Aerated water was boiled on commercial copper tube surface, heated electrically from inside. The electrical heater was switched on when the temperature of the water was 203° F. (Boiling point of water at atmospheric pressure is 207.4° F.). The nucleation on the tube surface was photographed every three minutes after switching on the electrical heater.

The following history of the boiling liquids is evident from the figures. Since the heater is switched on even before boiling point of the liquid is reached, numerous gas bubbles nucleate on the heater surface (see Fig. 1).



FIGS. 1-6. Boiling of aerated water from copper tube surface: Fig. 1. At start. Fig. 2. After six minutes. Fig. 3. After twelve minutes. Fig. 4. After eighteen minutes. Fig. 5. After twenty-four minutes. Fig. 6. After thirty minutes.

However, as they escape from the surface, they collapse in the bulk of the liquid, because of condensation of vapour thus leaving a swarm of minute gas bubbles (Figs. 2 and 3). As the bulk liquid temperature reaches the boiling point of the liquid, the bubbles do not collapse but grow because of the evaporation of the superheated liquid into the bubble. This development can be seen in Figs. 4, 5 and 6. It can further be seen that the nucleus density decreases as time elapses since the dissolved gas content has depleted.

Dept. of Chem. Engg., V. N. RADHAKRISHNAN.  
Indian Inst. of Sci., N. R. KULOR.  
Bangalore-12 (India),  
June 4, 1964.

### ALASKAN EARTHQUAKE AND GRAVITY TIME-CURVE

AN Askania Gravimeter (G.S. 11) is being used to record the variation of gravity value with time since last few years at Hyderabad for studying earth tides and for detecting earthquakes both natural and artificial. The effect of several earthquakes and nuclear explosions on earth tide records have been studied and reported earlier. It has been observed that the gravimeter which is being used also responds to minute disturbances, in the same way as a highly sensitive seismograph. A very large magnitude earthquake (magnitude-8) occurred in Alaska on 28th March 1964 and some interesting features of this have been reported by Tillotson.<sup>2</sup> The record obtained by the gravimeter in Hyderabad during the period 1,200 hrs. IST on 28th March to 0400 hrs. IST on 29th March 1964 is reproduced in Fig. 1. Four fairly large after shocks have been recorded after the main shock which itself lasted for about five hours beginning at 0920 hrs. IST. The subsequent shocks were felt (marked A, B, C and D) at 1700 hrs., 1845 hrs., 2115 hrs. and 0245 hrs. (on 29-3-1964) and they show a fairly high intensity suggesting a magnitude of about 6. Several smaller shocks also were

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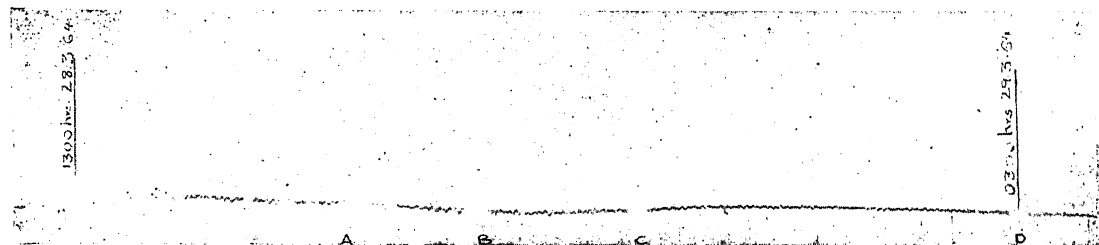


FIG. 1. Alaska earthquake: Main shock followed by after shocks, 28-3-1964.

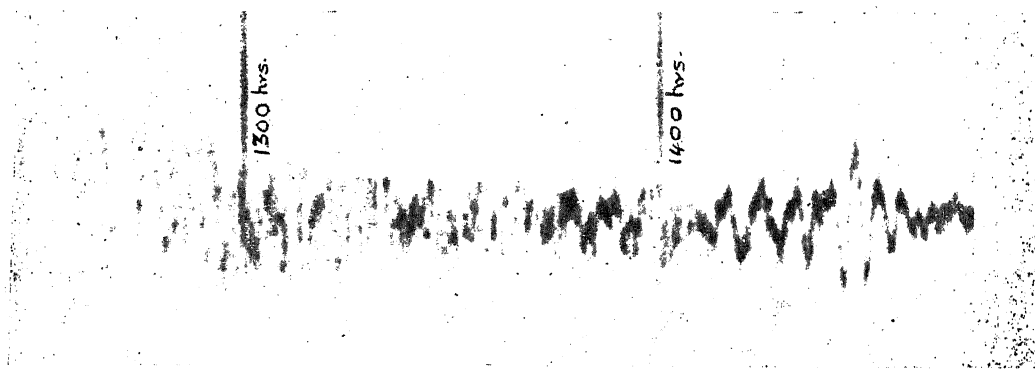


FIG. 2a. Alaska earthquake: Main shock, 28-3-1964.



| ← ————— 1 hr. ————— → |

FIG. 2b. Mexico earthquake, 6-7-1964.

found on subsequent records. This continued disturbance suggests that the earthquake is of a fairly intense type and possibly the natural frequency of earth has been excited. Another earthquake (Mexican) from about the same epicentral distance from our station was recorded by the gravimeter on 6th July, 1964, and Figs. 2 a and 2 b show the records of main shocks (same magnification) of both the Alaskan and Mexican earthquakes. The comparison suggests that although both earthquakes are of same epicentral distance their magnitudes are well reflected in the record patterns. Further, in the case of earthquakes of fairly intense magnitude after shocks are noticed as has been reported earlier both in the case of Chile earthquake and the 100 megaton nuclear explosion.

The authors desire to express their grateful thanks to Professor S. Bhagavantam for many valuable discussions and guidance.

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Osmania University, S. RAMAKRISHNA.  
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#### **PETROLOGICAL NATURE OF FUSINISED RESINS IN THE GONDWANA (PERMIAN) COALS OF INDIA \***

FUSINISED resins are known to occur in the Palaeozoic coals of Illinois,<sup>9</sup> America,<sup>15,16</sup> Antarctica,<sup>17</sup> and Australia.<sup>19</sup> The material described as "sclerotoids" in the coals of Canada,<sup>6,7</sup> and as sclerotinite in those of Germany<sup>1,18</sup> is quite similar in nature to the

fusinised resins; Kosanke and Harrison<sup>9</sup> have stated that "opaque resin rodlets with vesicles and canals resemble structures reported from Palaeozoic coals of Europe to be opaque sclerotia".

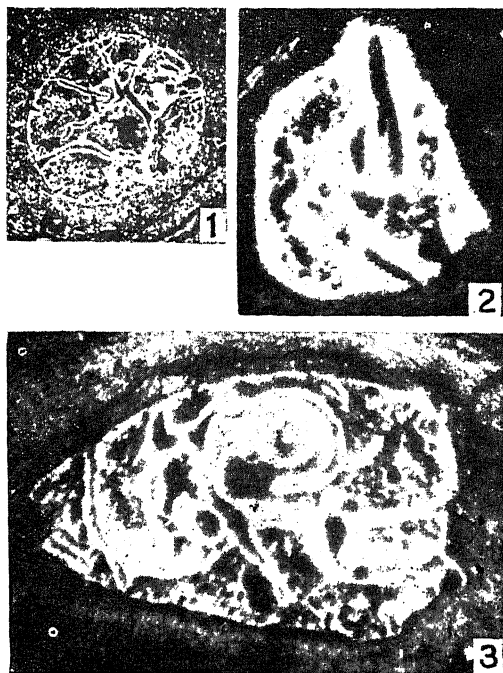
In the Gondwana (Permian) coals of India, the material interpreted as fungal remains<sup>2-4,8,10,11</sup> is confirmed by detailed studies to be in fact fusinised resin<sup>5,12,13</sup> and the maceral termed as fusi-resinite.<sup>14</sup> Sclerotia is in fact a rarity in these coals.

Fusinised resins are common to very common in the Karharbari coals of North Karanpura and Giridih coalfields; Barakar coals of Talcher, Pench-Kanahan and Godavari valley coalfields, and as traces or absent in the Barakar coals of Jharia and South Karanpura coalfields, and Raniganj coals from Dishergarh seam of the Raniganj coalfield.

Petrological study of the fusinised resins in the coals of the above different coalfields has indicated that they occur as medium to high-reflecting, bodies of size between 20 and 1,500 microns, and of variable shape. They occur either scattered in the micro-bands of durite, clardurite and duroclinite or concentrated as laterally-persisting bands in mostly durite. They have morphological characters, which are dependent on devolatilization and shrinkage that the resins underwent during fusinisation. Infinite variation could thus occur in their form, but only six types, classified as follows, in the decreasing order of their abundance, have commonly been observed.

I. Resin bodies with linear or curvi-linear, usually empty, voids known as canals, that may be medium or long, narrow or wide and run parallel or oblique to each other. Similar bodies described as fungal remains by Ganju

(Pl. 13, Fig. 5<sup>3</sup>), and as sclerotinite by Hoffmann and Hoehne (Fig. 45<sup>8</sup>), and Lahiri and Bhattacharya (Pl. II, Figs. 9 and 10<sup>10</sup>) are in fact fusinised resins of this type. It is the predominating type in all fusinised resin-rich coals, which thus suggests that the process involved shrinkage rather invariably.



FIGS. 1-3 Fig. 1. A round fusinised resin with several vesicles and many cracks. Chuni seam, North Karanpura coalfield. Polished section oil immersion,  $\times 100$ . Fig. 2. A vesicled fusinised resin with linear voids. Ross seam, Tander coalfield. Polished section, oil immersion,  $\times 200$ . Fig. 3. An intensely cracked fusinised resin of vesicled nature. Ross seam, Tander coalfield. Polished section, oil immersion,  $\times 210$ .

II. Bodies with a strongly vesicled interior and a thin non-vesicled outer rim, that may be intact, feebly cracked or extensively cracked, the cracks being of varying pattern and extend up to the centre of the body dividing it into several irregular parts (see Figs. 1 and 3). Similar bodies recorded as sclerotia by Ganju (Pl. 13, Fig. 3<sup>3</sup>; Pl. 13, Figs. 1 and 5<sup>4</sup>) are fusinised resins of this type; the vesicles were confused for plant cells.<sup>5</sup>

III. Vesicled bodies with a non-vesicled, moderately thick or thick outer rim, which represents the oxidized layer from which no gases could evolve. Similar bodies described as sclerotia by Benerjee (Pl. 13, Figs. 1, 2<sup>1</sup>) and Ganju (Pl. 13, Fig. 2<sup>3</sup>) are fusinised resins of this type.

IV. Massive bodies of homogeneous appearance. The material identified as fungal remains by Ganju (Pl. 3, Figs. 4, 6<sup>4</sup>) and as sclerotinite by Hoffmann and Hoehne (Fig. 46<sup>8</sup>) is fusinised resin of this type.

V. Bodies with elongate voids and vesicled interior (see Fig. 2).

VI. Bodies with vacuoles of variable shape and size, that are usually empty.

Geological Survey of India, H. S. PAREEK.  
3, Gokhale Marg,  
Lucknow, U.P. (India),  
July 29, 1964.

\* Published by permission of the Director-General, Geological Survey of India.

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### PALAEOARTHRODENDRON, A REVISED NAME FOR ARTHRODENDRON ULRICH

In 1897 Scott (in Seward, 1898, p. 301) wrote to Seward suggesting that the generic name of the calamitean stem described by Williamson (1871) as *Calamopitys* should be changed to *Arthrodendron*, since the former name had already been used by Unger in a different sense. Following this suggestion, Seward (1898, p. 301) applied the name *Arthrodendron* but as a sub-genus. However, Scott (1900) in his *Studies in Fossil Botany* used it as a genus.

Unaware of this prior use of the generic name *Arthrodendron*, Ulrich (1904, p. 138) instituted

the genus *Arthrodendron* with *Arthrodendron diffusum* as its genotype, for an alga from the Uakutat formation (Lower Jurassic) in Alaska. Thus there are two homonyms, used in different senses altogether. According to Art. 64 of the International Code of Botanical Nomenclature (Lanjouw *et al.*, 1961) the later homonym, that is, *Arthrodendron* Ulrich (1904) must be rejected. It is, therefore, necessary to give a new name to the fossil alga described by Ulrich. I suggest that it may be referred to a new generic name *Palæoarthrodendron*. Consequently, *Arthrodendron diffusum* should henceforth be known as *Palæoarthrodendron diffusum* (Ulrich) comb. nov.

For ready reference the original generic and specific diagnoses for the fossil alga are given below under the new name:

*Palæoarthrodendron* (ULRICH) NOM. NOV.

"Plant ramose, bushy, the branches constricted at regular intervals and probably consisting each of a series of rounded or ovate, flattened (originally inflated) joints, surface of joints minutely granopunctate."

*Palæoarthrodendron diffusum* (ULRICH)  
COMB. NOV.

"Branches moniliform, springing from a central point and spreading outwardly and upwardly so as to form a loose bush-like mass as much as 15 cm. in diameter; divisions dichotomous, at intervals varying from 6 mm. to over 20 mm. Joints sub-elliptical, the lower half usually a little narrower than the upper half, 4 mm. to 6 mm. in length and from 2.2 mm. to 2.8 mm. in width; surface usually glossy and smooth, but where the preservation is more favourable is covered by minute granules and punctæ."

My sincere thanks are due to Dr. R. N. Lakhnopal, Assistant Director, for going through this communication critically.

Birbal Sahni Institute of  
Palæobotany,  
Lucknow (India), July 22, 1964.

R. DAYAL.

# THE REPUGNATORIAL GLANDS OF *NECROSCIA SPARAXES* WESTWOOD (PHASMIDAE: PHASMIDA)

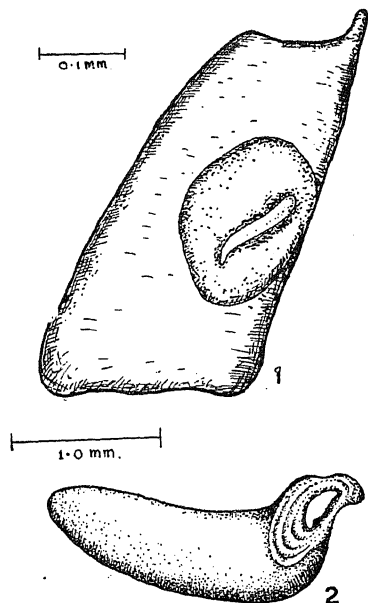
THE phasmid, *Necroscia sparaxes*, bears a pair of ectodermal openings of the repugnatorial glands on the dorso-lateral part of the prothorax above and in front of the bases of the fore-coxae in both sexes. A milky-white fluid is ejected by these glands, which is deposited on the first abdominal and metathoracic segments in the form of a fine mist and in droplets on the meso- and prothoracic segments, the bigger droplets being nearer the latter segment. The fluid is given out when the phasmids are touched or pressed.

Such glands are known to exist in other phasmids. Imms (1925) states that a pair of long tubular glands, apparently repugnatorial in function, is found in the prothorax of many phasmids and open in front of each fore-coxa. Littig (1942) has described in the Florida walking stick, *Anisomorpha buprestoides* Stoll. that an acrid fluid is elaborated in the thoracic repellent glands and the phasmids of both sexes can eject it to 10 to 18 inches in a fine mist and is considered to be protective. Scudder (1876) has called these pores of *A. buprestoides* as 'Foramina repugnatoria' on analogy with such pores of Myriapoda and has described the form of the glands and the milky-white liquid ejected from them.

The openings of the repugnatorial glands of *N. sparaxes* are situated in pits immediately behind the anterior transverse line of the prothorax. Each glandular opening is surrounded by a dark-coloured raised cuticular ridge of the body wall which is pink along its inner face (Fig. 1). The membrane of the pits is delicate, pale brownish and wrinkled (Fig. 2) and bears a fine slit in the centre to serve as an opening for the glands. The glands, however, lie in the body cavity of the prothorax on either side of the alimentary canal and above the salivary glands. The posterior end of each gland reaches the posterior extremity of the prothorax of both sexes. Each gland of *N. sparaxes* is pale white, elongate, saccular and broadly rounded posteriorly. It is slightly flattish on the sides facing the alimentary canal. In the anterior part of the prothorax, the gland is curved upward into a short, tapering neck which opens into the slit of the membranous pit on the cuticle (Fig. 1). The size of the glands is variable in both sexes. The length and width of the glands measure from 2.4 to 2.7 mm. and 0.7 to 0.8 mm. in the female and 1.8 mm.

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to 2.0 mm. and 0.3 to 0.4 mm. in the male respectively. The glands are broadest near the neck region which alone measures about 0.3 mm. in length.



FIGS. 1-2. Repugnatorial gland of female phasmid.

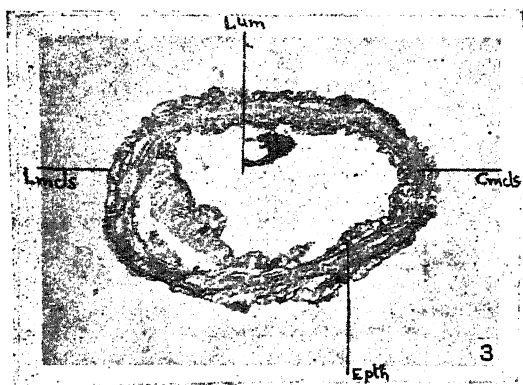


FIG. 3. Photomicrograph of repugnatorial gland of male phasmid.

The section (Fig. 3) of the glands of a male of *N. sparax* reveals the presence of a layer of longitudinal muscles (*Lmcls*) on the surface of the glands, followed by an inner layer of the circular muscles (*Cmcls*). The lumen (*Lum*) of the gland is lined by a narrow and flat epithelium (*Epth*) whose cells are also flat with round nuclei. From such a structure, it seems probable that the simultaneous contraction of

both muscles may be helpful in drawing the fluid upwards to the neck region for being ejected. Since the glands are present in both sexes, they may be protective in nature.

College of Agriculture, G. A. GANGRADE.  
Jabalpur, March 30, 1964.

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## RECORDS OF PARASITOLOGICAL INTEREST

### I. *Trypanosoma evansi* Infection in Bears

STAINED blood smears from a dead bear received from the clinical laboratory, Cuddapah, revealed large number of trypanosomes in the smear. On enquiry it was known that this bear had suffered from disease for some time and died.

A detailed study of the trypanosome (Fig. 1) in stained blood smear was made and the trypanosome was confirmed as *Trypanosoma evansi* on the basis of morphology and mensural data (Hoare, 1956).<sup>1</sup> The length of the trypanosomes in the smear varied from 15-24  $\mu$  with an average  $18.62 \pm 0.36$ .

To our knowledge there seems to be no record of *T. evansi* in bears though *T. evansi* has been recorded from a number of wild animals and hence this is the first record.

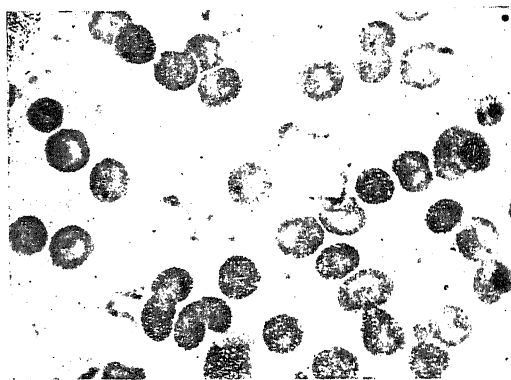


FIG. 1. Photomicrograph of *T. evansi* in Blood smear of bear,  $\times 1187.50$ .

1. Hoare, C. A., *Parasitology*, 1956, 46, 130.

### II. Twinning of Miracidia in the Egg of *Schistosoma nasale*, Rao, 1933 (Trematoda : Schistosomatidae)

In the course of studies on the eggs of *Schistosoma nasale* in Cattle, twinning of miracidia in a few eggs has been observed

(Fig. 2). Twinning of miracidia had been recorded in *Schistosomatum douthitti* (Short, R. B., 1952)<sup>1</sup> and *S. mansoni* (Hoffman, W. A. and Janer, J. L., 1936<sup>2</sup> and Janer, J. L. 1941).<sup>3</sup> Since there was no record of twinning of miracidia in eggs of *S. nasale*, this happens to be the first record.



FIG. 2. Photomicrograph of the egg of *S. nasale* with twin miracidia,  $\times 525$ .

The authors' thanks are due to M. Crawford,<sup>4</sup> Director, Commonwealth Bureau of Animal Health, England, for references and advice. Our thanks are due to Sri. P. S. Rajulu, Principal, for encouragement and to Sri. Jyothirlingam, Veterinary Assistant Surgeon, Cuddapah, for sending blood smears for diagnosis.

Dept. of Parasitology, A. VENKATARATNAM.  
Andhra Veterinary College, G. V. NAGARAJA RAO.  
Thirupathi, August 12, 1964. P. PADMAVATI.

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#### ABSORPTION OF FOLIAR-APPLIED $P^{32}$ BY GROUNDNUT PLANTS

In recent years, foliar application of mineral nutrients to crop plants and orchard trees has been receiving much attention, particularly for supply of phosphate.<sup>1</sup> The easy availability of radio-isotopes of the elements facilitated a study of their absorption, transformation and translocation in the plants when supplied as foliar sprays. In the present experiment  $P^{32}$  was applied to groundnut leaves and its distribution into different phosphate fractions was studied at short intervals.

Sodium dihydrogen phosphate with labelled P was diluted to the required activity. A drop (50  $\lambda$ ) of the labelled phosphate (activity 10  $\mu$ c./ml.) was applied to the upper surface of mature leaflets of two months' old groundnut plants (Variety TMV-2) grown in thoroughly washed river-sand supplied with Hoagland's nutrient solution with half P content. The treated leaflets were removed for analysis at intervals of 15, 30, 60 and 120 minutes after application. They were washed in the free phosphate solution with which dilution of the original radioactive solution was made to remove any labelled material adhering to the surface of the leaflet. Analysis of the different phosphate fractions was made following the standard method.<sup>2</sup> Organic and inorganic P ( $P_i$ ) fractions were separated by calcium precipitation method.<sup>3</sup> The leaflets were extracted in cold 0.2 N HCl. The supernatant after centrifugation of the extract contained the acid-soluble phosphate fraction which included  $P_i$  and soluble organic compounds. The residue was next extracted with 1 NPCA at 4° C. for 18 hours and centrifuged. The resulting supernatant contained RNA-P fraction. The activity in the three fractions was measured as counts per minute with an end-window GM-tube.<sup>4</sup> For each treatment three replicates were maintained. Along with samples, standards were simultaneously run for counting. The mean values are plotted in a graph (Fig. 1).

15 minutes after application of labelled P, both soluble organic and  $P_i$  fractions showed almost the same radioactivity. With time, the activity in the two fractions gradually increased. It was, however, higher in the  $P_i$  fraction. After 120 minutes, the  $P_i$  fraction contained the highest activity, three times higher than that of the soluble organic fraction. RNA-P fraction showed gradual increase from 15 minutes to 60 minutes and the rise was steep later on. However, incorporation of  $P_i$  into RNA remained at a lower level than in the other two fractions throughout the two hours. In young Soyabean leaves, 80% of  $P^{32}$  absorbed was present in organic compounds after 24 hours of application.<sup>5</sup> In one preliminary experiment with young groundnut plants, we also observed a similar trend. But in the present experiment with the older plants, the situation was reversed. Higher activity in the inorganic fraction in leaves of older plants can be attributed to lower metabolic activity leading to slow synthesis of organic compounds, than in the leaves of younger plants. When pea plants were fed with  $P^{32}$ , much

activity was found in the inorganic fraction while the organic contained only a small fraction of the total radioactivity in the leaf.<sup>6</sup> In bean plants, with a time interval of 30 minutes

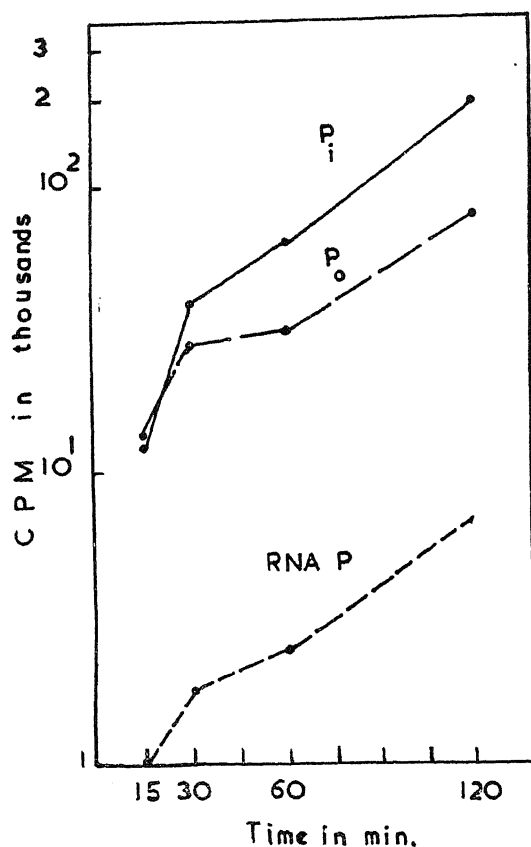


FIG. 1

after foliar application of P<sup>32</sup> in inorganic form, 20% of radioactivity was found in inorganic and over 50% in the hexose P fraction while after 120 minutes 90% was found in the P<sub>i</sub> fraction.<sup>7</sup> With increase of time, the activity was greater in the P<sub>i</sub> fraction, as observed in the present study.

We thank Dr. I. M. Rao, Professor of Botany, S.V. University College, for his valuable advice and encouragement given to us in this work.

Department of Botany, V. ANNAPURNA DEVI.  
S.V. University College, G. RAJESWARA RAO.  
Tirupati, August 9, 1964.

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#### PERONOSPORA FARINOSA (FR.) FR. ON CHENOPodium MURALE L.—A NEW RECORD FOR INDIA

In January 1964 a downy mildew of *Chenopodium murale* L. was observed at Kanpur. The undersurface of the affected leaves was covered with a greyish downy mycelial growth with corresponding pale spots on the upper surface. The affected areas became dirty black later on and the leaves eventually dried up. The diseased tissues were flooded with 70% alcohol, mounted in 5% KOH and warmed gently with a view to examine and measure turgid conidia and oospores under the microscope.

*Morphology of the fungus.*—Mycelium coenocytic, hyaline, intercellular, branched; haustoria large, elongated or club-shaped often branching and almost filling the host cells; conidiophores arising from the mycelium, hyaline,  $142.9-428.4 \times 4.8-9.4 \mu$  straight or slightly curved, bifurcating six to twelve times dichotomously at right angles, final branches short, straight or slightly curved and pointed, bearing a single conidium broadly oval, hyaline when young but slightly smoke-coloured at maturity,  $16.8-25.2 \times 14.7-21.0 \mu$  shedding readily and germinating sparingly by a lateral germ tube; oospore  $14.7-16.8 \mu$  in diameter, deep-seated within tissues of old withered spots with a pale yellow wall  $3.2-4.2 \mu$ , irregularly thickened and enclosing an oospore  $21-25 \mu$  in diameter.

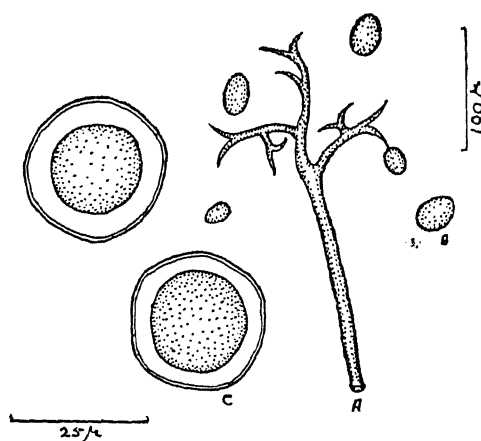


FIG. 1. A, Conidiophore; B, Conidium; C, Oospore.

Gaumann (1919) reported *Peronospora muralis* on *Chenopodium murale* from Europe and Mitter and Tandon (1930) reported *P. varibilis* Gaum. (syn. *P. effusa*) from Allahabad, India. Yerkes and Shaw (1959) merged a number of *Peronospora* species recorded on Chenopodiaceæ into one species *P. farinosa* (Fr.) Fr. Comparative measurements of the conidia of *P. muralis*, *P. farinosa* and our specimen are given in Table I.

TABLE I

Showing conidial measurements of *P. muralis*, *P. farinosa*, and the specimen under study

Fungus	Length ( $\mu$ )	Breadth ( $\mu$ )	Quotient
<i>P. muralis</i> ..	16.0-32.0	12.8-28.8	1.14
<i>P. farinosa</i> ..	25.0-35.0	16.2-26.2	1.31
Specimen under study	16.8-25.2	14.7-21.0	1.22

Except for the fact that on the basis of the maximum measurements in the range for our specimen which are rather small for *P. farinosa* or *P. muralis*, the description would fit with the *P. farinosa* complex. There appears to be no record of this fungus from India, although it is reported from Pakistan.

Thanks are due to Miss G. M. Waterhouse of the Commonwealth Mycological Institute, Kew, Surrey, England, for favour of confirming the identification (IMI 104802).

Section of the Plant Pathologist to Govt.,  
Uttar Pradesh,  
Kanpur, May 8, 1964.

S. C. VERMA.  
L. S. CHAUHAN.  
R. S. MATHUR.

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### A VIRUS DISEASE OF DOLICHOS LABLAB VAR. TYPICUM FROM MYSORE

DURING the year 1962-63, a mosaic disease, exhibiting large bright yellow patches on the leaves, was observed on the climbing bean plant, *Dolichos lablab* Linn. var. *typicum* Prain grown commonly in kitchen gardens in Hebbal and Bangalore. Later, the disease has been noticed in several other localities of the State. Since the symptoms suggested that the disease may be of virus origin, studies were undertaken on the symptomatology, mode of transmission and host range. The results of these investigations are reported in this paper.

All the experiments were conducted under insect-proof conditions. The culture of the virus for the studies was taken first from the naturally infected climbing bean plant collected near Hebbal and the same was maintained in the insect-proof cages in glass-house on transmitted plants. For graft transmission, the diseased scion and the healthy stock plants were used. For insect transmission tests, virus-free colonies of white-flies, *Bemisia tabaci* Gen. and *Siphonimus finitimus* Signoret., maintained in insect cages on their respective healthy hosts, tobacco and pomegranate were used.

Transmission tests under insect-proof conditions showed that the disease is readily transmissible to healthy climbing bean plants by wedge grafting. The virus is also transmitted by the white-fly, *Bemisia tabaci* but not by sap inoculation or through the seed. The other white-fly *Siphonimus finitimus* was unable to transmit the disease. The white-flies were given an acquisition feeding period of 12-24 hours and the transmission feeding of 24 hours. The results (Table I) show that the virus is readily transmissible by grafting and also by white-fly, *B. tabaci*.

TABLE I

Different transmission tests of the Dolichos yellow mosaic virus

Transmission by	Number of plants inoculated	Number of plants diseased
Sap inoculation	.. 30	0
Wedge grafting	.. 18	14
<i>Bemisia tabaci</i>	.. 10	5
<i>Siphonimus finitimus</i>	.. 8	0

The symptoms of the disease appeared in 14-20 days in the case of grafted plants (Fig. 1) and in 18-20 days in the case of white-fly-transmitted plants. In grafted plants, the symptoms of the disease appeared in the new branches below the grafted portion and in insect-transmitted plants in the next subsequent leaves, in the form of faintly discoloured patches on the leaf lamina. These gradually developed into bright yellow patches, leaving only a few patches of green tissues on the leaf (Fig. 2). It is observed that the disease has no correlation with the size and shape of the leaves and also the growth of the plant except significant reduction in yield.

The host range studies of the virus was confined to the members of the family Leguminosæ, subfamily Papilionatæ. It was successfully transmitted to *Dolichos lablab*, *D. lablab* var. *typicum* producing systemic mosaic symp-

toms. The virus however, could not be transmitted to *Canavalia gladiatus* (Jacq.) DC,

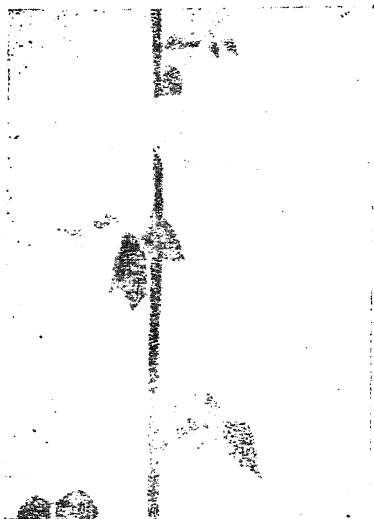


FIG. 1. Grafted plant of *Dolichos lablab* var. *typicum* showing typical symptoms of yellow mosaic.

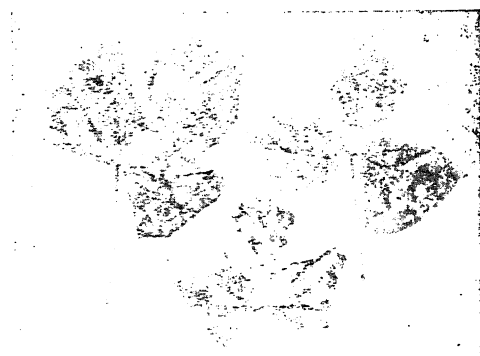


FIG. 2. Diseased leaves of *Dolichos lablab* var. *typicum*. *Phaseolus lunatus* Linn., *P. vulgaris* Linn., and *Vigna catjang* Walp. (Table II).

TABLE II

Host range studies of the Dolichos yellow mosaic virus

Name of the plant	Number of plants inoculated	Number of plants diseased
<i>Canavalia gladiatus</i>	6	0
<i>Dolichos lablab</i>	7	5
<i>D. lablab</i> var. <i>typicum</i>	28	19
<i>Phaseolus lunatus</i>	6	0
<i>P. vulgaris</i>	6	0
<i>Vigna catjang</i>	6	0

The virus under study in its symptomatology, mode of transmission and host range resembles the "YELLOW MOSAIC of *Dolichos lablab*"

reported earlier by Capoor and Verma (1950), who stated that this virus is transmitted by white-fly, *Bemisia tabaci*. The graft transmission is reported for the first time for this virus.

Division of Plant Path., R. C. YARAGUNTIAH.  
Agricultural Res. Inst., H. C. GOVINDU.  
Hebbal, Bangalore-24,  
September 22, 1964.

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### POLLEN GRAINS OF GREVILLEA VESTITA MEISSN.

THERE are three main types of pollen grains in the Proteaceae: (1) the ellipsoidal, biporate type found in the tribes Banksieae (*Banksia*, *Dryandra*), Musgraveae (*Musgravea*, *Austromuellera*) and Embothrieae (*Embothrium*); (2) the spherical, triporate type found in the Australian genus *Franklandia* (*Franklandia*) and the South African genus *Aulax* (*Protea*) and (3) the triangular, oblatly flattened, triporate type found in all the remaining genera of the family including *Grevillea*. The pollen morphology is so constant and characteristic of genera and tribes that it offers an important taxonomic criterion; the present writer founded the two tribes Musgraveae and Embothrieae mainly on the basis of the ellipsoidal biporate pollen (Venkata Rao, 1957).<sup>3</sup>

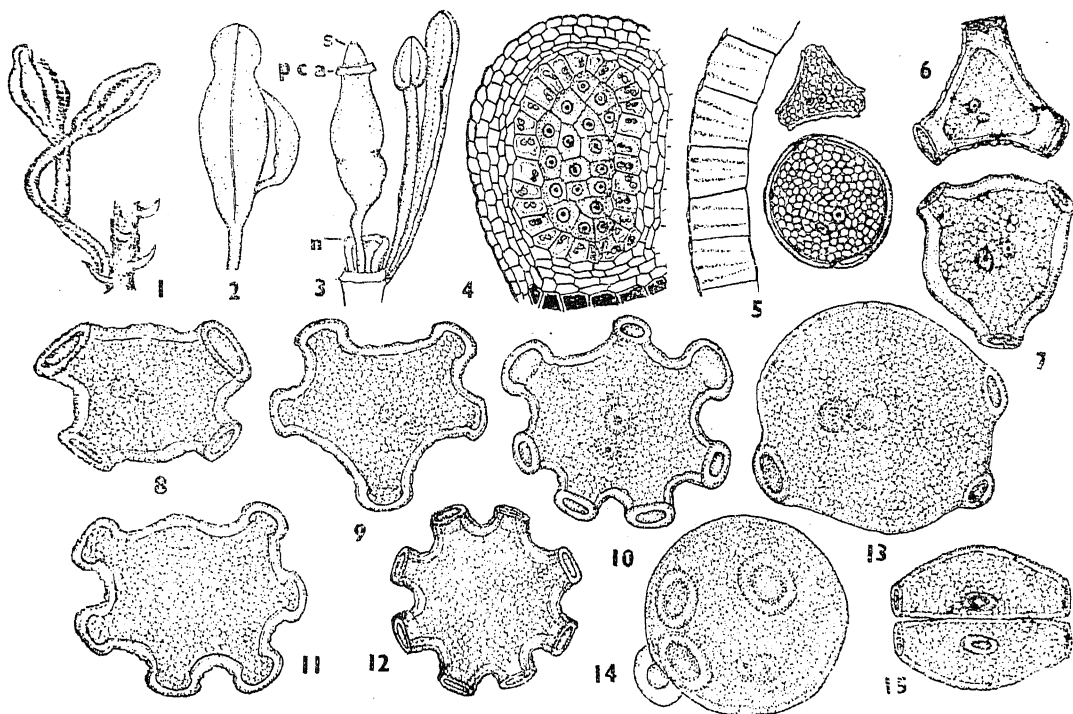
Cookson and Erdtman (Erdtman, 1952)<sup>1</sup> studied the pollen morphology of about 300 species belonging to 50 genera of the Proteaceae. The writer also made palynological observations in about 200 species of the family including 65 species of *Grevillea* ranging from different geographical regions. These observations show that the pollen grains in each species (except in *G. vestita*) conform to one basic type. Variations about the basic type are so uncommon that they can be regarded as abnormalities. In species with triangular, triporate pollen, the occurrence of 4- or 5-porate grains is so occasional and sporadic that their presence is revealed only by intensive observations.

*Grevillea* R.Br. is the largest genus of the Proteaceae with about 260 species of which 14 are endemic in New Caledonia, 2 in New Guinea, 2 in Malaysia, 1 in Tasmania and the rest are distributed in East, South and West Australia. *G. vestita* Meissn. is a West Australian species; material fixed in formalin-acetic-alcohol was collected by the writer in August 1957 from Perth.



*G. vestita* is a small shrub 6-9 ft. high. The flowers occur in lax racemes and show the paired arrangement characteristic of all Grevilleoideae (Fig. 1). The flowers are long-pedicelled, monochlamydeous and 4-merous. There are 4 antetepalous stamens, a zygomorphic,

sporogenous cells undergo a secondary increase. The microspores mature into a number of pollen types, each with a relatively high frequency (Figs. 6-15). Ramsay (1963)<sup>2</sup> who reported  $n = 10$  in *G. vestita* does not mention of any irregularities in meiotic divisions in sporocytes.



FIGS. 1-15. Fig. 1. Part of inflorescence showing a pair of flower-buds,  $\times 1.5$ . Fig. 2. A mature flower-bud,  $\times 2.5$ . Fig. 3. Pistil, nectary and a tepal with its associated stamen,  $\times 2.5$ . (s, stigma; pca, pollen-collecting apparatus; n, nectary). Fig. 4. T.s. anther lobe,  $\times 90$ . Fig. 5. T.s. part of mature anther locus showing fibrous endothecium and two pollen grains,  $\times 120$ . Figs. 6-12. Pollen grains with 3-8 germ pores. Figs. 13-14. Spherical pollen grains. Fig. 15. A dyad. Figs. 6-15,  $\times 168$ .

semi-annular nectary, a stipitate ovary with a terminal stigma subtended by a discoid pollen-collecting apparatus. In some flower-buds the filaments of the stamens are adnate to the tepals, a condition common in the family. In some others, however, they are seen to be free to the very base (Fig. 3). A random observation of the pollen of this species revealed high degree of polymorphism unnoticed in any other member of the family.

The anthers in *G. vestita* are 4-locular and develop normally. The anther wall is 5-6-layered below the epidermis. The hypodermal layer develops into the fibrous endothecium and the innermost 1-2 layers into the tapetum which is of the secretory type; the middle layers become crushed out eventually (Figs. 4, 5). The

For knowing the relative frequency of the different types, the pollen grains from 5 flower-buds were mounted separately under rectangular coverslips and the slides were scanned (Twenty-five counts were made from each slide from seams 2 mm. apart; the length of the seam is 18 mm. and the width  $250\mu$ ). The results are presented in Table I.

The results show that though the triangular, triporate type (Fig. 6) characteristic of the genus *Grevillea* forms the majority of the pollen, they are less than 50% of the total grains. Sometimes the triporate grains become large and somewhat irregular (Fig. 7). Other grains show 4, 5, 6, 7 and 8 germ pores which may be arranged in a symmetrical or asymmetrical manner. Sometimes the pollen grains enlarge

TABLE I

Slide No.	3-porate	4-porate	5-porate	6-porate	7-porate	8-porate	Spherical	dyads	Total
1	31	24	40	31	3	0	2	3	134
2	55	19	46	31	5	2	1	1	160
3	147	16	22	11	1	0	2	0	199
4	57	29	51	34	6	0	0	6	183
5	32	12	16	22	7	1	3	2	95
Totals and Percentages	322 41.7	100 12.9	175 22.7	129 16.7	22 2.8	3 0.4	8 1.0	12 1.5	771

considerably and develop into irregular or spherical structures with variable number of germ pores (Figs. 13, 14). It can be seen that the grains with higher number of germ pores are increasingly rarer. Occasionally pollen grains attached in dyads were noticed (Fig. 15). Two-pored grains, however, were not encountered. The 3-pored basic type of grains were the smallest in size ( $48 \times 55 \mu$ ) and the sac-like grains the largest with a diameter up to  $100 \mu$ .

The internal structure of the pollen grains shows that the majority of them are fertile. The exine is much thicker than the intine. The sexine is thinner than the nexine and irregularly thickened. The germ pores are shed in the 2-celled condition. The cytoplasm is packed with starch grains (Fig. 5).

The presence of semi-annular nectary, stipitate ovary and pollen-collecting apparatus are features in which *G. vestita* resembles other species of *Grevillea*. But the tip of the flower-bud does not become reflexed (Fig. 2) as it does in several species of *Grevillea*, accentuating the zygomorphy of the flower. The absence of adnation of stamen and tepal is to be regarded as a primitive feature not noticed in other *Grevilleas*; in fact this condition is seen in only one other member of the family, viz., *Bellenden montana*, a monotypic Tasmanian endemic (Venkata Rao, 1960).<sup>4</sup> Since the meiotic divisions in the microsporocytes proceed normally and since most of the pollen grains are fertile, the high degree of polymorphism noticed in the pollen of *G. vestita* seems to be due to some genetic factor.

The writer wishes to express his thanks to the Staff of the Department of Botany, West Australian University, for the facilities provided for collection of the material. His thanks are also due to Mr. C. Subba Reddi for scanning the slides.

Department of Botany,  
Andhra University,  
Waltair, May 30, 1964.

C. VENKATA RAO.

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### EFFECT OF PLANT ROOT EXUDATES ON THE EGG MASSES AND LARVAE OF THREE ROOT-KNOT NEMATODES

THE results on the studies on pathogenicity and life-cycle of three root-knot nematodes occurring on solanaceous hosts in South India are being reported elsewhere.<sup>1</sup> In the present report the effect of root exudates on hatchability of the egg masses and their attraction to the larvae of root-knot nematodes are briefly described. The effect of root exudates on egg masses of *Heterodera* spp. has been reported by Viglierchio and Lownsbery.<sup>2</sup> Weiser<sup>3</sup> and Lownsbery and Viglierchio<sup>4</sup> have shown the selective attraction of plant roots to nematode larvae.

In the present studies the egg masses and larvae of three root-knot nematodes, viz., *Meloidogyne arenaria* from brinjal, *M. incognita* from chilli and *M. javanica* from tomato were used. The root leachate for the studies were collected from the local varieties of the three host plants, following the procedure of Calam *et al.*<sup>5</sup> Ten egg masses of the nematode species, with uniform size, colour and consistency, were selected and placed in a hatching unit, designed as per the model of Viglierchio.<sup>6</sup> In each unit 5 ml. of the leachate was added and 5 ml. of sterile water served as check. The egg masses were incubated at room temperature ( $27^\circ$  to  $29^\circ$  C.) and counts on the hatch taken every 24 hours. The results are given in Table I.

The egg masses of *M. arenaria* showed lesser hatch in the root leachate than in water, whereas the egg masses of *M. incognita* and *M. javanica* showed almost similar hatch as in water.

For testing the attractability of the root exudates to nematode larvae, an experiment was set up, similar to the one designed by

TABLE I

Hatching responses of the eggs of three root-knot nematodes in the root leachates of their respective natural hosts

(Average number of larvæ hatching out from each egg mass, incubated in a dark, humid chamber at 27-29°C.)

Incubation days	<i>M. arenaria</i>		<i>M. incognita</i>		<i>M. javanica</i>	
	In brinjal root leachate	In sterile distilled water	In chilli root leachate	In sterile distilled water	In tomato root leachate	In sterile distilled water
1	23	34	21	19	31	28
2	32	39	26	28	23	22
3	31	33	28	27	36	38
4	31	37	27	28	28	27
5	29	36	31	27	40	39
6	38	50	24	19	45	45
7	29	40	21	25	35	36
8	30	37	20	19	32	35
9	32	38	11	17	20	21
10	30	30	20	19	31	15
Total	305	374	229	228	321	306

Each figure represents an average of the larvæ emerging out of 90 egg masses.

Lownsbery and Viglierchio.<sup>4</sup> The bottom plate of a 10 cm. Petri-dish was divided into four tightly sealed equal compartments, radiating from a central circle of 5 mm. diameter wherein a correctly fitting tube of tissue paper was inserted. The compartments and also the central column were filled with fine, washed, sieved and sterilized sand, over which a sterile filter-paper was placed. Sprouted seeds of brinjal, chilli or tomato were placed on the filter-paper in each of the compartments, at the rate of 5 in each, all at a distance of 3 cm. away from the column. Thus three different plant species were kept in the three compartments and the fourth was vacant. When water was added through the central column it diffused into the compartments and moistened the filter-papers through which the seedlings absorbed the moisture. The root exudates also soaked and spread out in the paper. After two-day incubation, a suspension of the nematode larvæ in water was added to the central column. The larvæ placed in the column had to work their way out by piercing through the paper, before they had an opportunity to choose their host root in the compartments. After 24-hour incubation the seedlings and the filter-paper in each compartment were removed and the number of larvæ were carefully counted. The data on the tests carried out with the three species of nematode larvæ, in each case using all the three plant host species, are presented in Table II.

TABLE II

The influence of root excretions on the migration of the larvæ of three root-knot nematodes (Data represent average of four replications)

Treatment	Root-knot nematode species					
	<i>M. arenaria</i>		<i>M. incognita</i>		<i>M. javanica</i>	
	No. of larvæ counted	% over total	No. of larvæ counted	% over control	No. of larvæ counted	% over control
Check (without plants)	39	12.5	82	22.4	16	4.5
Brinjal seedlings	75	24.9	96	19.1	50	14.2
Chilli seedlings	159	51.1	175	48.4	145	41.3
Tomato seedlings	38	12.2	35	9.7	140	39.8

Final readings taken 24 hr. after the addition of larvæ into the central column of the dishes.

The larvæ of all the three nematode species had initially spread out in all directions, irrespective of the presence of root exudate or not, but finally there was larger accumulation of the larvæ around the plant roots than in the check. Chilli seedlings seem to attract relatively more numbers of larvæ of all the three nematode species, brinjal coming next. As observed in the pathogenicity and cross-inoculation studies (Chidambaranathan and Rangaswami<sup>1</sup>) chilli seedlings are resistant to infection by *M. arenaria* and *M. javanica*. This might be due to stronger chemical attraction of the root exudates from chilli than from the other two hosts. While brinjal seedlings attracted more of *M. arenaria* and *M. incognita*, tomato attracted more of *M. javanica*, its own natural parasite, as compared to the other two species. These results confirm the reports of Wallace<sup>7</sup> and Viglierchio<sup>8</sup> on other root-knot nematodes.

Microbiology Lab., A. CHIDAMBARANATHAN.  
Faculty of Agriculture, G. RANGASWAMI.  
Annamalai University,  
Annamalainagar, Madras, August 28, 1964.

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## REVIEWS

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**Comparative Nutrition of Man and Domestic Animals**, Vol. 2. By H. H. Mitchell. (Academic Press, Inc., 111, Fifth Avenue, New York 3, New York), 1964. Pp. 840. Price \$ 20.00.

This two-volume work presents and correlates, in a quantitative fashion, the nutrient requirements of man and his domesticated animals and the factors that modify these requirements. It had its inception in a graduate course in comparative nutrition at the University of Illinois developed during a period of some thirty years. In parallel with the development of the course, an experimental research program was pursued concerned with studies of the chemical growth and nutritive requirements of both animals and human subjects. The ripe experience of the author in these fields is to be found embodied in these volumes.

The first volume, dealing with "The Nutrient Requirements in Terms of Body Expenditures and Storages", has already been reviewed in the issue of *Current Science* for November 1963. The second volume now under review consists of three sections dealing respectively with (1) vitamin requirements in terms of dietary equivalents; (2) the utilisation of dietary nutrients and (3) fulfilment. The treatise was written with the training and the interests of graduate students in mind, particularly those interested in physiology, biochemistry or nutrition as their major subjects. It will also be of great interest to specialists in these fields. C. V. R.

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**Clinical Biochemistry of Domestic Animals**. Edited by Charles E. Cornelius and Jiro J. Kaneko. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xii + 678. Price \$ 20.00.

With the expansion and growth of veterinary science, clinical animal biochemistry plays an increasingly important role in animal medicine. For, the data obtained regarding the changes occurring in the chemical constituents of the blood and tissues enable a better understanding of the disease process and supply information helpful in diagnosis, therapy and prognostication. The book under review represents an attempt to provide the veterinary student and practitioner of veterinary medicine with infor-

mation concerning the interpretation of biochemical findings in diseases of domestic animals. The gap between the fundamental sciences and the practice of clinical animal medicine is thereby sought to be bridged.

The book is a co-operative endeavour. All the authors are distinguished specialists in their respective fields. It will be realised, therefore, that the work should prove of great value to those interested in the applications of biochemistry to veterinary science. The book consists of thirteen chapters: the subjects dealt with and their respective authors are listed below: Carbohydrate Metabolism by J. J. Kaneko; Lipid Metabolism by E. J. Carroll; Plasma Proteins by George T. Dimopoulos; Porphyrins and the Porphyrins by J. J. Kaneko; Liver Function by Charles E. Cornelius; Selected Organ Function Tests by J. J. Kaneko; The Kidney: Its Function and Evaluation in Health and Disease by John Bentinck-Smith; Cerebrospinal Fluid by Charles E. Cornelius; Synovial Fluid by Charles E. Cornelius; Transudates, Exudates, and Miscellaneous Fluids by Ernst L. Biberstein; Calcium, Inorganic Phosphorus, and Magnesium Metabolism in Health and Disease by Mogens G. Simesen; Fluids and Electrolytes by Hans Meier; Use of Radioactive Isotopes in Veterinary Clinical Biochemistry by J. R. Luick. C. V. R.

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**The Life of the Rainbow Lizard**. By Vernon A. Harris. (Hutchinson Educational Limited, 178-202, Gt. Portland St., London W. 1), 1964. Pp. 174. Price 21 sh.

Rainbow lizards are familiar animals in tropical Africa, and their habits make them ideal subjects for the study of animal behaviour. The book under review is based upon the observations by the author made when he was Lecturer in Zoology at the University of Ibadan. It is well written, has numerous illustrations and is printed and got up in attractive fashion. It is, therefore, assured of a warm reception.

Few animals show greater contrast in appearance than the Rainbow Lizard and its mate. The book contains amongst other things, an interesting discussion of the manner in which the observed colour changes of the animals are effected. It is noteworthy that red or green pigments have been found in the melanophores.

It is inferred that the blue colour has a physical origin and the green is derived from it by the superposition of the effect of a yellow pigment.

C. V. R.

**Biochemistry of Phenolic Compounds.** Edited by J. B. Harborne. (Academic Press, Inc., Ltd., Berkeley Square House, London W. 1), 1964. Pp. 618. Price \$ 18.50.

The "Phenolic Compounds" considered in this volume include all natural substances with a free or a masked phenolic function. Until recently, such substances were ignored by biochemists and were only seriously investigated by organic chemists. During the last decade, however, the emphasis has shifted and increasing efforts have been made to determine their function in plants and animals. In particular, the introduction of tracer techniques has provided the means of studying the biosynthesis of phenols. It is no longer possible, therefore, to ignore the very real biological importance of these substances. The appearance of the volume under review which deals comprehensively with this field is, therefore, warmly to be welcomed.

The book under review consists of fourteen chapters: their respective authors and the subjects dealt with are the following: (1) R. H. Thomson—Structure and Reactivity of Phenolic Compounds; (2) M. K. Seikel—Isolation and Identification of Phenolic Compounds; (3) J. B. Harborne and N. W. Simmonds—The Natural Distribution of the Phenolic Aglycones; (4) J. B. Harborne—Phenolic Glycosides and Their Natural Distribution; (5) Ralph E. Alston—The Genetics of Phenolic Compound; (6) R. T. Williams—Metabolism of Phenolics in Animals; (7) G. H. N. Towers—Metabolism of Phenolics in Higher Plants and Micro-organisms; (8) A. C. Neish—Major Pathways of Biosynthesis of Phenols; (9) S. A. Brown—Lignin and Tannin Biosynthesis; (10) E. E. Conn—Enzymology of Phenolic Biosynthesis; (11) H. W. Sieythesis—Physiological Studies on Phenolic Biosynthesis; (12) P. W. Ramwell and H. S. A. Sherratt and B. E. Leonard—The Physiology and Pharmacology of Phenolic Compounds in Animals; (13) I. A. K. Cruickshank and Dawn R. Perrin—Pathological Function of Phenolic Compounds in Plants; (14) Robert M. Horowitz—Relations between the Taste and Structure of Some Phenol Glycosides.

C. V. R.

**X-Ray Optics and X-Ray Microanalysis.** Edited by H. H. Pattee, V. E. Cosslett and Arne Engstrom. (Academic Press, New York), 1964. Pp. xvii + 622. Price \$ 22.00.

This volume contains the papers presented at the Third International Symposium, in the triennial series of symposia on X-ray optics and X-ray microanalysis, held at Stanford University in August 22-24, 1962. It may be recalled that the first symposium was held at Cambridge, England, in 1956, and the second at Stockholm, Sweden, in 1959. The 52 papers in this volume contributed by 77 scientists are chiefly concerned with the new developments that had taken place during the three-year interval since 1959, in various aspects of X-ray microanalytical techniques including instrumentation, methods of study and applications.

A perusal of the contents shows that nearly half the number of papers deal with the technique of electron-probe microanalysis and its applications. It shows the importance of this new technique and the impressive degree of development it has reached in recent years. It promises to become an indispensable tool of research with wide applications in such diverse disciplines as metallurgy, medicine, biology and astronomy.

The underlying principle in electron-probe or X-ray scanning microanalysis is the one made familiar by television. In a television tube the image on the screen is produced by the electron spot exciting visible light where it strikes a coating of a special material, the phosphor. In the X-ray scanning microscopy the flying electron-probe (a finely focused electron beam of diameter less than 1  $\mu$ ), excites X-rays in the specimen itself, which are recorded in a counter, the signal from which is amplified, modulated and displayed by well-known electronic devices. As the characteristics of the X-radiation and its intensity are intimately connected with the content and composition of the part of the specimen scanned by the electron-probe, a close study of the displayed image with suitable techniques will at once give quantitative microanalytical details of the specimen.

The versatility of the technique can be readily appreciated from the following titles wherein the results obtained by its use have been described: "The application of the electron-probe microanalyzer to metallurgy and mineralogy", "Electron-probe measurements near phase-boundaries", "Some biological applications of the scanning microanalyzer", "Electron-probe microanalysis of biological specimens", "Use of elec-

tron microprobe analyzer in the study of binary metal alloy system". As to its application in astronomy the use of the technique to measure the nickel/cobalt ratio in meteorites may be cited. The question of composition of metallic grains in basic achondrites has an important bearing on the evolution of these meteorites. But their rarity and small sizes have made accurate conventional chemical analysis difficult. X-ray electron-probe microanalysis helps here.

The volume which is excellently produced with a large number of plates, graphs and diagrams, provides up-to-date information about the technique of X-ray microanalysis and its multifarious applications and, besides being a welcome guide book for workers in this new field of research, will provide material to enthuse further researches.

A. S. G.

**Horizons in Biochemistry—Albert Szent-Györgyi Dedicatory Volume.** Edited by M. Kasha and B. Pullman. (Academic Press, New York and London), Pp. xiv + 604. Price \$16.00.

Albert Szent-Györgyi is one of the great living scientists of today and this dedicatory volume is symbolic of his unified approach to all science, particularly those dealing with living systems. He wrote: "We will really approach the understanding of life when all structures and functions, all levels, from the electronic to the supramolecular, will merge into one single unit." In fact the volume under review contains articles on the whole range of phenomena connected with life at the molecular level.

Starting with a chapter on Albert Szent-Györgyi and Modern Biochemistry, the book is divided into six sections—Biochemical Evolution, Molecular Genetics, Biochemical Catalysis, Molecular Organization, Biochemical Molecular Structure and Quantum Biochemistry. The contributors range from such pure physicists like Leon Brillouin, through chemists like Linus Pauling to biochemists like Severo Ochoa and Arthur Kornberg. Some of the chapter headings show the speculative and thought-provoking nature of many of the essays—Giant molecules and semiconductors, Evolutionary possibilities for photosynthesis and quantum conversion, From Quantum Chemistry to Quantum Biochemistry, Is DNA a self-duplicating molecule? etc.

The book should be kept on the shelf and read again and again. It should find a place in every library devoted to any field related to the biological sciences.

G. N. R.

**The Indian Ephemeris and Nautical Almanac for the Year 1965.** (Published by the Manager of Publications, Civil Lines, Delhi), 1964. Pp. xxviii + 464. Price: Inland Rs. 14-00. Foreign 32 sh. 8 d. or 5\$ 4 cents.

With the publication of the present issue for 1965, the Ephemeris has now stepped into its eighth year of publication, and shown a continuous improvement in the quantity as well as the quality of the material presented. The fundamental change, introduced in 1960, of adopting Ephemeris Time instead of Universal Time has been kept up, and a further number of modifications pursuant to the above change has been incorporated in the present issue. The Explanations at the end of the Ephemeris constitute a very valuable contribution.

Mention is made in the Preface of an international agreement, in the calculation and compilation of the figures relating to the various tables, according to which each country obtains some complete data by exchange with the other countries. While several such advance data received from other sources are duly acknowledged, it is not clear however what exactly is the labour shared by our Nautical Almanac Unit in the supply of data published in the Ephemerides of the other participating countries.

A good deal of valuable information concerning the positions of the Sun, Moon and Planets, computed very accurately, is included in the Ephemeris so as to provide data for the use of indigenous almanac-makers of the country. In fact, this has been one of the objects of the Ephemeris ever since 1958, but we have so far not seen any *Panchanga* published either in the North or the South, making use of the valuable data provided. We think it is time that more positive steps are taken to prevail upon the indigenous almanac-makers to adopt the correct data.

We are glad to say that the publications of several years of our Ephemeris and Nautical Almanac have contributed greatly towards the development of astronomical studies in the country.

B. S. M.

**Plant Diseases: Epidemics and Control.** By J. E. van der Plank. (Academic Press, New York and London), 1963. Pp. xvi + 349. Price \$10.

Ever since the great devastations by late blight and rusts plant pathologists have been devoting increasing attention to the study of epiphytotics. The present work is perhaps the first one of its kind dealing with many important aspects of epidemiology and plant disease con-

trol. As the author himself has pointed out the book brings together our recent knowledge on methods of studying increase of pathogen population, and is a valuable supplement to the third volume of the Treatise of Horsfall and Dimond.

The relations between amount of inoculum, infection rate and the resulting disease are analyzed critically. A clear distinction is made between what the author calls vertical and horizontal resistance, and the roles of sanitation and use of resistant varieties as methods of control have been examined with reference to the type of resistance chosen. The novel idea that epiphytotics could be potential weapons in war has been put forward and defence measures suggested. A chapter on designing field experiments is also provided.

Only those possessing a sound training in mathematics will be in a position to appreciate the book properly.

T. S. SADASIVAN.

*Advances in Pharmacology*, Vol. 2. Edited by S. Garattini and P. A. Shore. (Academic Press, New York), 1963. Pp. viii + 392. Price \$ 12.00.

The outcome of planned research in pharmaceutical industry has been the production of a wide range of chemicals with potent therapeutic potentialities. The main hurdle in their introduction to clinical use appears to be the evaluation of their toxicity. The experimental methods presently available for the detection of the toxic properties of the drugs in animals are not perfect. No single standardized technique can yield all toxicity data.

The innumerable problems facing the pharmacologist engaged in toxicity studies; functional, biochemical and structural aspects of drug toxicity in humans; design of toxicity experiments; the factors affecting the outcome of animal toxicity and the extent of applicability of animal experimental conclusions to human are exhaustively treated in the review on 'Drug toxicity'.

How the genetic variations in laboratory animals influence the pharmacodynamic action of drugs is well illustrated in the chapter on 'the Potentialities for and present status of pharmacological research in genetically controlled mice', which also envisages the possibility of utilizing pharmacological studies to

analyse mammalian gene action and discover new mutations.

In 'Hormones and Atherosclerosis', we find that a fruitful field awaits researchers who endeavour to explain the species and territorial differences in the responses of atherogenesis to endocrine factors. The anatomical and biochemical features of atherosclerosis as influenced by gonadal, pancreatic, thyroid, pituitary and adrenal hormones portrays the complexity in presenting a single unified concept for the development of atherosclerosis.

The progress achieved in the treatment of *Myasthenia gravis*, the survey of 'The pharmacology of nitrogen mustards and related alkylating agents', and the 'Role of purine and pyrimidine antimetabolites in cancer chemotherapy' are other interesting topics reviewed in this volume.

M. SIRSI.

#### Books Received

From : (Academic Press, Inc., Pub., 111, Fifth Avenue, New York-3):

*Physiology of the Amphipica*. Edited by J. A. Moore, 1964. Pp. xii + 654. Price \$ 18.00.

*Introduction to Lattice Theory*. G. Szasz, 1964. Pp. 229. Price \$ 8.50.

*Spectra Structure Correlation*. By J. P. Phillips, 1964. Pp. ix + 172. Price \$ 6.00.

*Electron Microscopic Anatomy*. Edited by S. M. Kurtz, 1964. Pp. xii + 425. Price \$ 14.00.

*Experimental Chemotherapy* (Vol. III). Edited by R. J. Schnitzer and F. Hawking, 1964. Pp. xvii + 647. Price \$ 25.00.

*The Proteins—Composition, Structure and Function* (Vol. II, Second Edition). Edited by Hans Neurath, 1964. Pp. xiii + 840. Price \$ 26.00.

*Advances in Chemotherapy* (Vol. I). Edited by A. Goldin and F. Hawking, 1964. Pp. xi + 579. Price \$ 17.50.

*Recent Progress in Hormone Research* (Vol. XX). Edited by G. Pincus, 1964. Pp. viii + 606. Price \$ 21.00.

*Progress in Astronautics and Aeronautics—Guidance and Control* (Vol. XIII). Edited by M. Summerfield, 1964. Pp. xv + 997. Price \$ 14.25.

*Introduction to Infra-Red and Raman Spectroscopy*. By N. B. Colthup, L. H. Daly and S. Wiberley, 1964. Pp. xii + 511. Price \$ 12.00.

*Computing Methods in Optimization Problems*. Edited by A. V. Balakrishnan and L. W. Neustadt, 1964. Pp. x + 327. Price \$ 7.50.

## SCIENCE NOTES AND NEWS

*Solanum khasianum* var. *Chatterjeaeanum* Sengupta: the Richest Source of Solasodine

P. C. Maiti, Sipra Mookerjee, Rebeka Mathew and A. N. Henry, Chemical Unit, Botanical Survey of India, 76, Lower Circular Road, Calcutta-14, write:

With a view to finding out a rich source of solasodine, the steroidal alkaloid which can be converted to progesterone in a remarkably high yield,<sup>1</sup> a critical survey of the family Solanaceæ has been undertaken in this laboratory. The whole work when completed will appear as a monograph but the very recent publication<sup>2</sup> on the berries of *Solanum khasianum* Clarke has prompted us to make this communication. That solasodine is found in the berries of *S. khasianum* Clarke was earlier reported by us in a paper presented in a symposium held in Calcutta in April 1964. In fact we got a much higher yield of solasodine (1.13%) in the berries of *S. khasianum* Clarke than Chaudhury and Rao<sup>2</sup> (0.32% approx.).

We have so far studied twenty species of *Solanum* of which only few appear promising but amongst them we have the richest source of solasodine so far reported in literature.<sup>3</sup>

These are the mature fruits of *Solanum khasianum* var. *Chatterjeaeanum* Sengupta; the solasodine content is 5.4% on the dry weight of the fruits.

The work is being financed by P. L. 480 fund.

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**Gold Mining Industry in India (Memoir 1 of the Geological Society of India, Race Course Road, Bangalore-1).**

The Geological Society of India was started in 1958 with the object of promoting the cause of advanced study and research in all branches of geology with special reference to India. The Society brings out an annual journal containing original papers relating to the geology of India and closely allied subjects. The Society also organizes symposia and meetings in furtherance of its objective.

A symposium of topical importance, in the context of the establishment of the National

Mineral Development Corporation (NMDC) by the Indian Government, was the one on "Gold Mining Industry in India" organized by the Society at Bangalore on 26, 27, 28, August 1960. It was significant that one day of the symposium was held at Kolar itself, the great gold mining centre of India.

The Proceedings of the symposium appear as the first Memoir of the Society. It contains contributions from well-known geologists who have been intimately connected with the different aspects of the geology of gold—its exploration, prospecting, mining (including deep mining) beneficiation, etc.,—and who can speak with authority on the subject. Among the articles are: "The gold industry in India" by M. S. Krishnan; "Gold occurrence in Mysore and their prospects for large-scale exploitation" by B. Rama Rao; "Investigations for gold in India by the Geological Survey of India" by B. C. Roy.

The Memoir containing as it does authoritative information in the subject (including maps, plates, charts and data) becomes a valuable publication to those concerned with gold mining industry in India and its development.

**Neutron Activation Analysis to Determine Age of Paintings and Origin of Marble Sculptures**

The determination of the age of paintings by a neutron activation analysis was the subject of a paper presented by J. P. W. Hautman from the Reactor Institute, at Delft, Netherlands, at I.A.E.A. Symposium on Radiochemical Methods of Analysis, held at Salzburg, Austria, in October 1964. By taking samples of the paint of no more than one milligramme, and submitting them to a neutron bombardment, the impurities contained in the white lead of the colours are themselves rendered radioactive. The radioactivity of these impurities can then be determined. Lead colours having been in use since the Middle Ages, and the methods of purifying lead having changed appreciably during the centuries, the nature and quantities of impurities such as copper, silver, quicksilver, chromium, manganese, zinc and bismuth can be determined. They thus provide an indication as to the age and origin of a painting. Neutron activation has made it possible to detect such impurities where no more than one part in a million was present.



Neutron activation was also used by two Swiss scientists, Ladislaus Rybach and Hans-Udo Nissen, to determine the origin of marble used for sculptures or as building materials in Ancient Greece. By measuring the sodium and manganese content of marble samples taken from old quarries in Greece and Anatolia, the origin of archaeological finds can be determined, the authors stated.—(I.A.E.A. News Release.)

#### Electron Beam Scanning to Detect Defects in Semiconductor Crystals

A new technique developed at Bell Telephone Laboratories enables to study internal crystal defects in semiconductor diodes without damaging the specimens. The basic equipment used is a standard scanning electron microprobe. It produces a finely focused electron beam that probes the specimen at a depth determined by the energy of the beam. The beam diameter is about  $1\mu$  and the beam energies range from 4-50 Kev.

When the scanning electron beam probes the  $p-n$  junction of a semiconductor diode, the diode produces a response current. This current is amplified and fed to a cathode ray tube where it is displayed as a picture. Crystal defects cause a reduction in response current and appear as dark regions in the picture.—(J. Frank. Inst., 1964, 278, 225.)

#### Hypersonic Velocity in Liquids

An acoustic impedance method of determining hypersonic velocity in liquids has been described in a recent communication to *Physical Review Letters*. Acoustic waves at a frequency 3 GHz are generated by an  $x$ -cut quartz crystal excited by means of a cavity resonator. The damping of the crystal vibration, due to radiation into a liquid placed in contact with the vibrating crystal, is observed. The method yields the specific acoustic impedance,  $\rho V$ , of the liquid. Since the electrical power in the cavity is less than one milliwatt, heating of the liquid is negligible.

Results of hypersonic velocity (in m./sec. at  $20^\circ\text{C.}$ ) in water, acetone and carbon tetrachloride as determined are given below. Figures in brackets give the ultrasonic velocity. Water  $1480 \pm 20$  (1490); acetone  $1180 \pm 20$  (1190);  $\text{CCl}_4$   $972 \pm 5$  (938).

The close agreement between hypersonic and ultrasonic velocities in water, in which there is no experimental or theoretical evidence for expecting dispersion at this frequency indicates the suitability of the method and experimental set-up. While no dispersion is observed in the case of acetone, contrary to some earlier reports, carbon tetrachloride shows dispersion at this frequency.—(Phys. Rev. Letters, October 5, 1964.)

#### Region of Persistent Strong Flares in the Sun

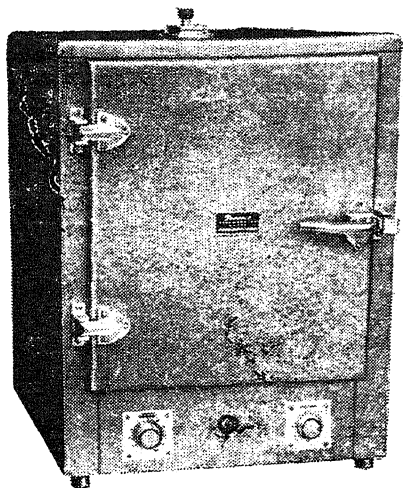
Solar occurrences like flares and sunspots are localised and, in many cases, last for a considerable time. Information about their localisation, duration and recurrences can be obtained by systematic observation of the effects they produce at the earth. If a solar occurrence persists for a duration which is many times the period of the sun's axial rotation (27 days) then there will be observed a corresponding periodic variation in the terrestrial effect observed. The 27-day recurrences of geomagnetical disturbances following a solar activity are well known.

Intense solar flares also give out particles of high energy which reach the earth and its outer space. In recent years systematic observations have been made on these particles and data relating to their energies have been collected both on the earth and in free space using satellites. These solar-particle events are classified according to their integrated intensity and correlated with occurrences in the sun. An analysis of the records of 56 such events collected during the last solar cycle between January 1955 and October 1962 has revealed some interesting conclusions regarding the region of activity in the sun. In particular, flares from a single  $10^\circ$  interval ( $80^\circ$  and  $90^\circ$ ) heliographic longitude caused most of the larger solar-particle events over the last solar cycle. This indicates the existence of a centre for the formation of active regions which has persisted for more than 73 solar rotations.

The general conclusion is that flares which produce energetic particles arise predominantly in narrow longitudinal regions which outlive visible active regions. This points to the existence of long-lived active centres beneath the photosphere which periodically manifest themselves on the surface as active regions which produce flares that accelerate solar particles—(Phys. Rev. Letters, 21 September 1964.)

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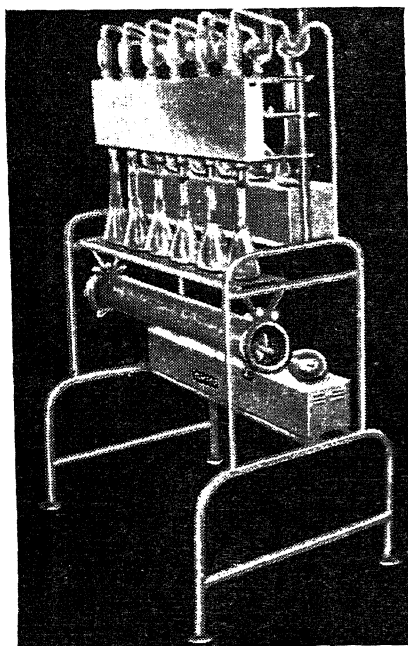
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# THE NEW PHYSIOLOGY OF VISION

## Chapter VII. The Perception of Colour in Dim Light

SIR C. V. RAMAN

THE existence in the human retina of the two kinds of structures known respectively as the rods and the cones led to the widespread belief that these structures have different functions to perform; that the cones form the "day-retina" which perceives colours and which adapts itself to darkness quickly but only to a small extent: that the rods on the other hand constitute a "night-retina" which has only colourless vision and a sensitivity which increases but slowly and over a wide range as the period in darkness becomes longer. We have now to consider whether it is possible to reconcile these beliefs—any of them or all of them—with the facts of observation elicited by the author's studies and set out in the two preceding chapters. The answer to these queries will become evident when the circumstances in which those observations were made are recalled, as we shall presently proceed to do.

The facts which may be grouped together under the description of the colour-luminosity relationship may first be considered. This relationship emerges when the chromatic sensations excited by the individual rays of the spectrum are studied in relation to the magnitude of the light-flux which reaches the retina. The observer views an extended surface on which the light is incident. It is found that as the illumination of the surface is progressively diminished, the chromatic sensation becomes weaker and weaker and tends to approach an achromatic sensation in its character. This effect is manifested by light from all parts of the spectrum and over the entire range of illumination covered by the observations. It is thus clearly a general characteristic of human vision. No question of differentiating between rod-vision and cone-vision can therefore arise in the context of colour perception.

The second group of observations concerns itself with the relative luminosity of the different parts of the spectrum as perceived by the eye at various levels of illumination. The observations are made by a very simple method; the spectrum of the light-source is viewed directly, a diffraction-grating held in front of the observer's eye enabling this to be done. The features of the spectrum as thus observed are

found to be quite different at the higher and at the lower levels of illumination. In the former case, the entire spectrum ranging from the red to the violet is observed. But, in the spectrum as observed in dim light, the red region is totally absent; the rest of the spectrum which extends into the green and blue-violet exhibits colour in a perceptible measure, though much less impressively than in the spectrum as seen in bright light. These features are perceived only if the observer has adapted his vision by a sufficient stay in semi-darkness to the low level of illumination at which they manifest themselves. In either case, when viewing the diffraction spectra and recognising their characteristics, the observer makes use of the foveal region of his retina which, as is well known, contains only cones and no rods.

Thus, while recognising that human vision exhibits different characteristics in "bright light" and in "dim light", we have to remark that the facts do not require us to describe them as vision with colour and without colour respectively. Neither do they require us to identify them with the functioning of the cones and the rods respectively. The need for a lengthy period of adaptation which is a characteristic of "dim light" vision is readily explicable. It is clear that the material needed for the perception of very feeble light is only slowly replenished in the retina when the eye is in the dark and that, *per contra*, it is rapidly removed or destroyed when the eye is exposed to bright light. We are under no compulsion to assume that such replenishment is a specific function of the rods in the retina. On the contrary, it seems more probable that this is accomplished elsewhere in the retina and that the material, if present, would be available for use alike by the rods and by the cones. The facts of observations set forth above indeed suggest that this is actually the case. They indicate that the cones can also function in dim light and in doing so utilize the material present in the retina which makes such vision possible.

*Chromatic Sensations in Dim Light.*—What has been stated above leads us back to a topic which was briefly touched upon in the previous chapter of the work, *viz.*, the colours exhibited

by various objects in dim light as compared with their appearance in bright light. It is not possible for us to deal with this topic here at all fully for the reason that colour as seen in daylight is the sensation resulting from the synthesis by the eye of the whole spectrum of radiations falling upon the object and returned to the eye after scattering or diffusion by the material of which it is composed. The visual synthesis of colour thus coming into play is a great subject in itself and we shall not here anticipate what will appear about it in later chapters. But it is appropriate that a few observations and remarks are recorded here, supplementing what has been said under the same heading in the preceding chapter.

The fact that colour perception is at all possible in dim light is itself both interesting and important. For the observations to possess any real significance, it is necessary that the observer should have adapted himself by a sufficiently prolonged stay in semi-darkness to the low levels of illumination employed. Further, it is necessary that the illumination under which the objects are viewed is itself not stronger than can properly be described as "dim light". To enable this condition to be satisfied, the observations should be made in a room of which the illumination can be controlled and brought down to the desired low values. The arrangement described earlier—a circular window through which sky-light is admitted and of which the diameter can be reduced by an iris-diaphragm—is well suited for the purpose. A convenient test-object which ensures that the illumination is low enough is a plastic sheet of brilliant red colour having a clean polished surface. When the illumination falling on the sheet is reduced sufficiently, it turns completely black, so much so that a plate of black glass held against it is invisible. It is desirable that the objects under view are also held or viewed against a dark background. This is conveniently arranged by placing them against a plastic sheet of brilliant red colour, or alternatively on a steel plate covered by enamel of a brilliant red colour. As seen in dim light, either of these devices serves the desired purpose in a very satisfactory manner.

A great variety of material offers itself as suitable for studies of the kind indicated. Perhaps the most interesting materials are flowers, by reason of the availability of numerous colours and shades of colour from plants of the same species, thereby enabling some useful comparisons to be made. Roses, for example, can be

had which are perfectly white; others are of various shades ranging from the palest to the deepest yellow: other roses exhibit colours ranging between a brilliant orange and a flaming scarlet; roses are also common which are various shades of red, ranging from the palest rose to the deepest crimson. One can arrange a whole series of coloured roses in a row and observe how the observed colours alter as the illumination is progressively reduced down to the dimmest possible.

Useful material for a study of colour at low levels of illumination is also available in the form of the plastic sheets of various hues, the colour in such cases being exhibited by the light diffused within the material, the sheets themselves being more or less perfectly opaque to light and exhibiting a smooth polished surface which does not scatter light. Varied colours and varied shades and depths of colour are readily available. The author had samples of thirty different sorts at his disposal which could be arranged in a regular colour sequence, thereby enabling their behaviours to be readily compared with each other.

We shall content ourselves by briefly stating the general nature of the effects observed in such studies. All objects which are a brilliant red in colour become black and are practically invisible in dim light. *Per contra*, all objects which are white in bright light continue to be white in dim light. This is not such a trivial observation as it might seem to be at first sight. Indeed, it might well be considered to be a remarkable and significant fact that when the entire region of the spectrum which appears red in bright light has been eliminated, the visual effect of the rest of the spectrum as perceived in dim light remains unaffected.

Another noteworthy observation is the behaviour in dim light of objects which exhibit a yellow colour in bright light. Spectroscopic examination shows that the colour of such objects is the result of the elimination of the blue-violet sector of the spectrum; the more complete this extinction is, the more brilliant is the yellow. Yellow flowers or other objects exhibiting that colour are conspicuously luminous as seen in daylight. They continue to be luminous objects as seen in dim light and their yellow colour is also readily recognisable in such light. As in the case of white flowers, the elimination of the red region of the spectrum has no perceivable effect on the observed results.

Spectroscopic examination shows that flowers which appear of an orange colour in daylight

exhibit a powerful absorption in the green part of the spectrum, the yellow and the red sectors being unaffected. In dim light, these flowers are barely visible objects, even against a dark background and their colour is scarcely noticed. These results are not surprising since in the spectrum of dim light, the red sector is very absent while the green sector, which is still intense, partly ceases to be effective because of its absorption by the material of the flower.

By far the most familiar objects exhibiting a green colour are the leaves of plants. The hues

exhibited by them vary, a greenish-yellow, a vivid green and a dark green being the shades most commonly observed. In a later chapter we shall have occasion to discuss in detail the origin and nature of these variations. Here it is sufficient to remark that after the necessary adaptation of his vision to the dimly lit surroundings, the observer can readily recognise the green colour of leaves and their variations. The highly decorative deep blue flowers of the "Morning Glory" are barely visible in dim light and then exhibit a just detectable bluish hue.

### IS THE MICROSPORANGIUM OF ANGIOSPERMS WALL-LESS?

R. PERIASAMY AND B. G. L. SWAMY

*Department of Botany, Presidency College, Madras*

IN a discussion of morphology of the angiosperm, Huxley (1941) has categorically stated that the microsporangium of angiosperms is a wall-less structure, viz. state that lies embedded in the tissue of the sporophyll. Further he considers this as a rather unique feature which distinguishes the angiosperms from the other groups of plants, and one that must be taken into account as an important aspect in consideration regarding the phylogeny of angiosperms. In literature pertaining to the life-history of angiosperms, however, what is repeatedly referred to as the anther wall appears to have been generally looked upon as the microsporangial wall not only in a functional sense but also in a morphological sense. Since the view of Huxley is completely at variance with the generally held opinion, it is necessary to examine this fact more critically and establish the validity of either one or the other of the two different views.

First of all it is necessary to clarify the issue and what must be considered as the attributes of a sporangial wall. From the functional point of view, any tissue that surrounds and protects the spore mass may be considered as the sporangial wall but it may not be so in a morphological sense. Thus there are instances in the lower groups of plants where sterile cells or the lower epidermis grow around it and function as a protective covering around the spore mass. Such a covering cannot be considered as a sporangial wall in a morphological sense because, ontogenetically as well as morphologically, it is not a part of the sporangium

proper but something external to it. In fact, the absence of formation of a sterile covering by the sporangia and gametangia is one of the chief characteristic features that distinguishes the thallophyta from the higher groups of plants. Phylogenetically, the morphological entity of true sporangial wall is considered to have been derived by sterilization and setting apart of a certain amount of the peripheral portion of the spore mass for the function of protection. The validity of this assumption is also strongly supported by evidence from ontogeny wherein it is seen that the initials of those cells that later develop into the sporangial wall have their origin from the same initial or initials that give rise to the spore mother cells. Therefore, the chief attribute of a morphologically true sporangial wall is that it should arise from the same initial as that of the spore mother cell.

In order, however, to determine matters on the basis of the above criterion, it is necessary to establish a concept which would enable us to determine at what stage a cell may be considered as having become an initial. The recognition of an initial as a distinct entity among a group of cells is usually done on the basis of differences in morphological attributes such as cell shape, cell size, protoplasmic configuration, etc., or by the onset of a characteristic plane of segmentation different from the neighbouring cells. Certain morphogeneticists (Wardlaw, 1955) are, however, of the opinion that from a physiological point of view, the initial might in certain instances at least be considered as having become differentiated much earlier to the mani-

festation of such externally visible morphological features. While this may be true, there does not appear to be any method of finding out the onset of such a physiological differentiation. For all practical purposes, therefore, we have to rely only upon the morphological criteria and segmentation pattern for the identification of an initial.

Leaving aside the naked sporangia of the lower plants, the first recognizable initials of the sporangia of the higher plants are generally referred to as the archesporium. The archesporium may consist of a single cell or a group of cells, and becomes recognizable from the neighbouring cells by differences both in morphological attributes and subsequent plane of segmentation. It arises either from the superficial layer—the epidermis—or from a deeper layer, which happens to be the hypodermis in most instances. While a superficial origin characterises the bryophytes and the pteridophytes, a hypodermal origin is a feature met with in the gymnosperms and the angiosperms. The implications of the shift of the initials from the superficial to a deeper layer is not much understood. Phylogenetically, however, the deep-seated origin appears to be the more advanced; morphogenetically, it is thought by some (see Foster and Gifford, 1959), that it might have some correlation with the organization of a tunica in the shoot apex. Whether such a correlation or correlation of a different sort can be postulated on the basis of available knowledge, shall be discussed on a subsequent page.

Concomitant with the shift in the position of the initials, there has also been a change in the configuration of the sporangium especially in regard to its manner of attachment. In general it may be stated that the stalked sporangium of pteridophytes has become sessile in the gymnosperms and sunken in the angiosperms. As a result of this, the extent to which the sporangial wall proper extends over the sporangium also becomes decreased. In the stalked sporangium, the wall extends around the entire sporangium; in the sessile one, it envelops the sporogenous tissue for a major part excepting at the basal region where it is usually constituted of non-sporogenous tissue; in the sunken sporangium, the sporangial wall proper usually becomes restricted to half or less than half of the surface area of the sporangium, the rest of the wall being constituted by other tissues. Thus, the reduction in the extent of the morphologically true

sporangial wall appears to be an important feature that has gone hand in hand with the modification of the sporangium.

In the light of what has been said above, we may now examine the state of affairs that obtains in the microsporangium of angiosperms. A perusal of literature concerning the development of the anther and the microsporangium of angiosperms shows that in all instances a more or less well-defined archesporium becomes differentiated in the hypodermis, and that the cells of the archesporium divide periclinally to give rise to an outer primary parietal layer and an inner sporogenous layer.

The wall layers of the microsporangium are formed by periclinal and anticlinal divisions of the primary parietal layer, and the innermost of the wall layers that lies adjacent to the sporogenous tissue, later on functions as the tapetum. However, as stated already, due to the sunken nature of the sporangium, the wall layers as well as the tapetum, which arises from it, extend along the external face alone of the sporangium about half or less than half of its circumference. That the inner half of the sporangium towards the connective is sunken in the tissue of the latter, is also borne out by the fact that the archesporium does not undergo any periclinal division towards the interior and that the divisions of the cells of the "connective" that abut on the archesporial cells do not show regularity in the periclinal and anticlinal orientations characteristic of the divisions of the primary parietal layer on the exterior face. Consequently, also the inner portion of the tapetum which arises from these more or less irregularly disposed cells abutting on the sporogenous mass, most often shows, especially during the early stages of its differentiation, an irregular arrangement in contrast to the tapetum on the external face which shows a very regular arrangement. The absence of a clear-cut differentiation between the tapetal and the sporogenous cells during the early stages of ontogeny, coupled with the lack of a regular line of demarcation between the two towards the interior face, often make it difficult to distinguish between the sporogenous cells and the tapetal cells at this region. A critical examination of the developmental stages, however, shows that in most instances the tapetal cells on the interior face arise usually from the cells of the connective tissue that earlier abutted on the archesporium and later on, on the sporogenous mass.\*

\* The morphology of the microsporangial tapetum will be discussed in a forthcoming publication.

Nevertheless, the probability that some of the sporogenous cells on the interior face or elsewhere may become modified and sterilized to form a small or large part of the tapetum cannot be ruled out in certain instances at least. In any case, however, there is no periclinal division of the archesporial cells or the primary sporogenous cells along the inner face and no reliably reported record of such an occurrence is in evidence.

In contrast to the state of affairs along the interior, sunken face of the sporangium, the sequence of ontogeny is always unmistakably clear along the exterior face and in the tissue that arises from the primary parietal layer. The wall layers show a regular disposition, and in spite of the lack of a clear differentiation between the tapetal and the sporogenous cells in the initial stages of ontogeny, a regular line of demarkation makes it easy to distinguish between the two at this part. Thus, the very nature of the differences seen in the ontogeny along the exterior and interior faces of the microsporangium, from the time of its initiation as archesporium, up to the time of meiosis, is enough to warrant the conclusions that (i) the hypodermal archesporium is the initial of the microsporangium, (ii) the archesporium divides periclinally to give rise to the initials of the sporangial wall on the exterior face alone, and (iii) no wall layers are formed by the archesporium towards the interior face due to the sunken nature of the microsporangium.

The assumptions on which Eames (1961) bases his conclusion that the microsporangium is wall-less, are quite at variance with the above-described and well-established facts of observation regarding the development of the microsporangium. First of all, he dispenses away with the term archesporium itself as of no significance because of some presumed inconsistency in the application of the term. Thus he says that the term has been applied not only to the hypodermal initials but also to the sporogenous tissue at a late stage in ontogeny. In this connection it may be stated that the initiation and early divisions of the archesporium take place very early in ontogeny of the flower so that it is rather difficult to recognize the archesporium as a distinct entity in most instances unless adequately critical techniques of sectioning and staining are adopted. It is, therefore, no wonder that in earlier studies pursued at a period when microtechnique was not advanced, some inconsistency may exist in regard to descriptions concerning the archesporium. In

more recent literature dealing with the life-history of angiosperms (Maheshwari, 1950), however, there does not appear to be any ambiguity regarding the initiation and further behaviour of the archesporium. Evidences presented by recent literature are sufficient enough to consider the hypodermal initiation of the archesporium as the first recognizable initials of the microsporangium, as an established fact.

After dispensing away with the archesporium, Eames assumes that the wall of the microsporangium, including the epidermis, arises from tissues lying outside the archesporium, and from what he designates as a sporogenous meristem. While surely there can be no doubt regarding the origin of the epidermis from the tissues outside the archesporium, the middle layers have been reported in all cases to arise from the primary parietal layer, which in turn arises by periclinal division of the archesporium towards the external face. Thus the middle layers, whose origin is directly traceable to the archesporium, do constitute a true morphological wall of the microsporangium.

The third observation made by Eames is that the term endothecium has also been indiscriminately applied either to the hypodermis alone or to all the inner layers between the epidermis and the tapetum and hence is valueless as a morphological entity. While it is true that the fibrous thickenings are generally deposited in the cells of the hypodermal layer towards the exterior face alone, there are many instances where the wave of such a histological differentiation spreads to the subjacent layers and also to cells that lie in the immediate neighbourhood of the thecae towards the axial side. In applying the term endothecium collectively to the tissue that has developed fibrous thickenings, it may thus sometimes include, on the basis of histological similarities, other tissues in addition to the true wall layers, but the term has never been employed to signify other tissues to the exclusion of the true wall layers.

From the foregoing considerations it is clear that the formation of a morphologically true sporangial wall by the archesporium on the external face towards the epidermis cannot be denied. The number of wall layers that arise may vary in different species of angiosperms. But, whatever may be the number, all the layers except the one that adjoins the epidermis are usually lost by the time the sporangium is mature. The layer adjoining the epidermis becomes structurally modified with characteristic

thickenings as the endothecium or what is otherwise called the fibrous layer. In a majority of cases, the epidermis is also lost so that the endothecium which is the outermost layer of the true and morphological sporangial wall, alone serves as the functional wall of the mature sporangium. The loss of the epidermis, which is the only non-sporogenous tissue that lies outside the sporangium on the exterior face, makes the sporangium ontogenetically an exposed structure, leading thus to a loss of its embedded state also. There are, however, many instances where the epidermis persists and even becomes more prominent than the endothecium, but without the fibrous thickenings.

In this connection it is worthwhile to compare the microsporangium of angiosperms with that of the other tracheophyta in order to see whether any phylogenetic sequences are recognizable. As far as the gymnosperms are concerned, the sequences of ontogeny are exactly similar to that in the angiosperms, but the morphology of the mature wall differs. In the gymnosperms, it is the epidermis which lies external to the archesporium that becomes modified with fibrous thickenings into what is called the exothecium, and serves as the mature sporangial wall. Thus, even though a morphologically true sporangial wall arises during the early stages of ontogeny, it is completely lost at maturity so that here the sporangium may be considered as becoming ontogenetically a wall-less structure lying embedded in the tissue of the sporophyll—the epidermal exothecium.

The persistence and functioning of the epidermis as the mature wall of the microsporangium in the gymnosperms is perhaps a tendency comparable to the pteridophytes where the sporangial initials arise from the epidermis and consequently the formation of the sporogenous tissue as well as the wall is fundamentally a function of the epidermis. Even though in the gymnosperms, the position of the sporangial initials has become shifted to the hypodermis with an attendant formation of a true sporangial wall internal to the epidermis by the archesporium, the epidermis still appears to retain its earlier function and capacity to form at least the wall of the sporangium though not the sporogenous tissue itself. Because of this, the true sporangial wall formed internal to the epidermis becomes superfluous and is hence lost without any disadvantage at maturity of the sporangium. The behaviour of the epidermis is perhaps correlated with the lack of a well-

organized tunica in the shoot apex of gymnosperms due to which the epidermis is derived from the same complex of initials that give rise to the other layers. Hence, the epidermis, in spite of its characteristic organization and structure in the differentiated regions of the plant body, does not yet seem to have undergone a specific morphogenetic isolation from the other layers so as to become a merely superficial 'skin' concerned chiefly with the protection of the inner tissues—a condition that is seen to prevail in the angiosperms. Such a morphogenetic isolation of the epidermis probably began with the extension of the peripheral delimitation of the epidermal layer established earlier in the differentiated regions of the plant body, to the shoot apex itself, resulting in the organization of a tunica as the epidermal initials, distinct and separate from the initials of other layers, as is the case in almost all angiosperms. Thus, as far as the microsporangium is concerned, we see that in the angiosperms the capacity of the epidermis even to form the exothecium has been lost, so that it has nothing to do with the sporangium proper from the time of its initiation until its maturation and dehiscence; hence, the outermost layer of the morphological wall becomes necessarily the functional wall also of the mature sporangium. Even in those instances where the epidermis persists in the mature sporangium, the morphogenetic isolation is clear from the fact that it does not acquire the fibrous thickenings characteristic of the endothecium or the exothecium of gymnosperms.

It is therefore to be concluded that the microsporangium of angiosperms is not a naked and wall-less structure as has been recently described by Eames. On the other hand, it possesses a true morphological wall whose outermost layer alone serves as the functional wall at maturity. Due to the sunken nature of the sporangium, however, the extent of the wall around the sporangium is usually only half or less than half of the circumference along the external face of the sporangium.

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## NOTES ON THE EMBRYOLOGY OF *HEVEA BRASILIENSIS* MUELL.

A. N. RAO

Department of Botany, University of Singapore, Singapore

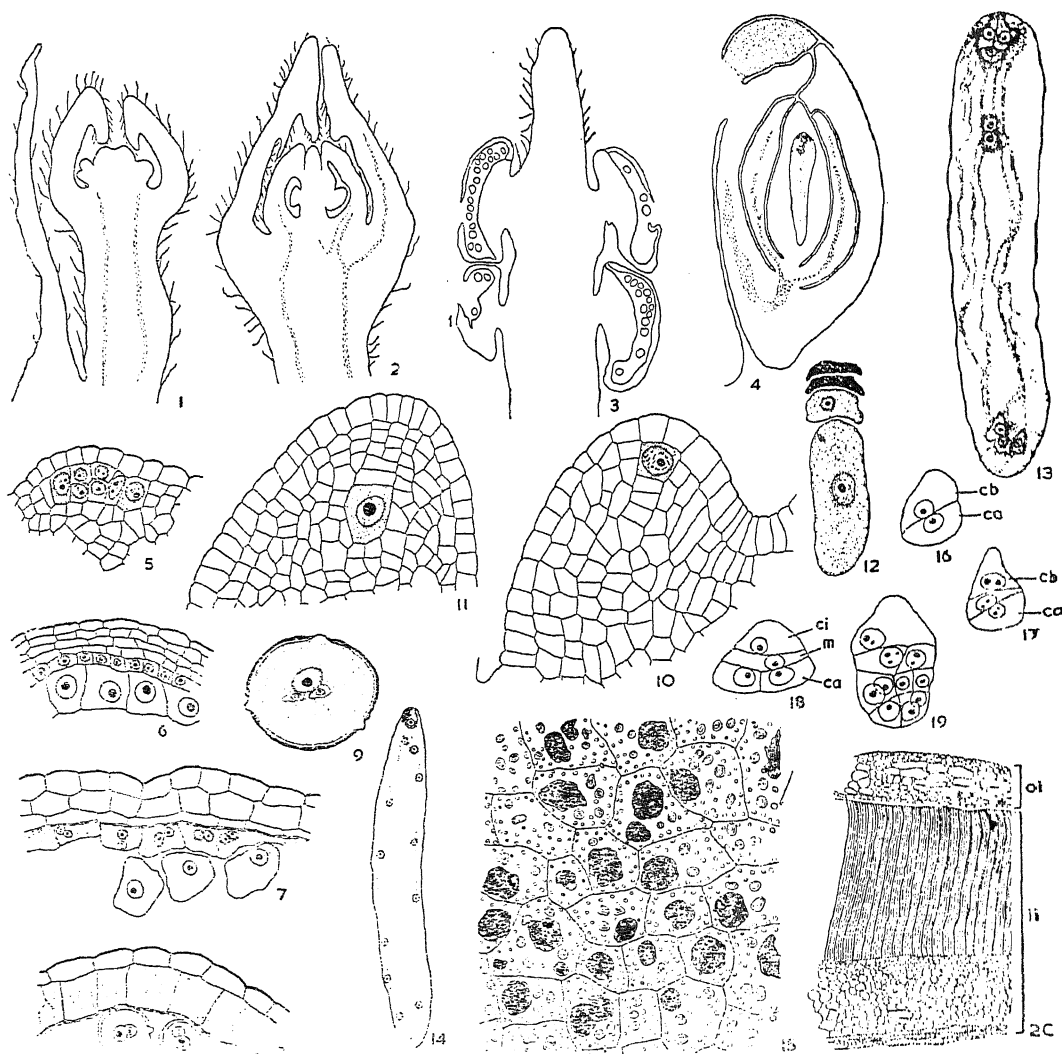
**S**INCE the classical publication of Schnarf,<sup>1</sup> many genera of Euphorbiaceæ have been embryologically investigated and the relevant points of such studies are summarized from time to time.<sup>2-6</sup> These references also reveal the lack of embryological data on *Hevea brasiliensis*—the rubber plant. Recently the floral anatomy of this species is described along with five other members of Euphorbiaceæ.<sup>7</sup> Certain observations made on the flower and seed development of *H. brasiliensis* are recorded here.

Pax<sup>8</sup> has placed this genus under the subfamily Platylobeæ, section Jatropheæ, along with other genera like *Jatropha*, *Aleurites*, etc. The rubber trees usually flower twice a year in Singapore, rarely more frequently as effected by high temperatures. While the bigger lateral branches of the panicle bear the male and female flowers, the latter occupying the terminal position of such a branch; the shorter laterals will have only male flowers. The bracteate flowers have five perianth lobes, which are green and thin in male flowers, orange cream and fleshy in case of female flowers. In both kinds of flowers the development of floral parts is in acropetalous succession and thick-walled unicellular hairs develop on all floral parts except the anthers (Figs. 1-3). The transection of very young anther shows a hypodermal archesporium of 5-6 cells, which divide to form the wall of the anther and the pollen mother cells (Figs. 5-8). The young anther wall shows an epidermis, endothecium, two middle layers, and glandular uninucleate tapetum (Fig. 6). Quadripartition of the microsporocytes takes place by centripetal furrowing resulting in tetrahedral quartets of microspores. The tricolpate pollen grains with a thicker exine are 2 or 3-celled at the time of shedding and the anther wall at this stage will have only epidermis and the fibrous endothecium (Figs. 8, 9).

The tricarPELLARY, superior ovary is trilocular with one or rarely two anatropous, bitegmic ovules arranged on axile placenta. The outer as well as inner integuments at the mature embryo-sac stage are made up of 6-8, or 10-12 layers of cells respectively. The micropyle is wavy in outline, organized by both the integuments, and occasionally the inner one stops, short, in which case the micropylar opening is surrounded by the outer integuments. The obturator is prominent as reported in many

other genera of this family<sup>9</sup> and persists for a long time during the seed development. The funicular strand enters the basal region of the ovule branches, which extend into the inner integument (Fig. 4). Similar instances are recently reviewed.<sup>9</sup> The hypodermal archesporial cell divides forming an upper primary parietal cell and a lower megaspore mother cell. The latter becomes deep seated due to the formation of a parietal tissue (Figs. 10, 11). The reduction division of the megaspore mother cells results in the formation of a linear tetrad of megaspores, of which the chalazal one develops further, the three others degenerating (Fig. 12). The nucleus of the functioning megaspore undergoes three more divisions to form an embryo-sac of the polygonum type. Even after the organization of chalazal and micropylar quartets the embryo-sac enlarges considerably, and sometimes the antipodals degenerate even before fertilization. The synergids are slightly hooked and the polars usually meet near the egg apparatus (Fig. 13).

Fertilization is porogamous and during the entry of the pollen tube, one of the synergids is destroyed, while the other degenerates subsequently. The primary endosperm nucleus divides forming free nuclear endosperm (Fig. 14). Cytokinesis around these would set in, starting from the micropylar end and extending towards chalaza. Most of the endosperm is utilized during the embryo development, and cells present in the mature seed show darkly staining bodies, starch grains and oil globules (Fig. 15). The zygote divides only after the formation of many endosperm nuclei. The first division of the zygote is transverse to form an apical cell *ca* and a basal cell *cb*. The cell *ca* divides vertically or obliquely and *cb* transversely forming a tetrad (Figs. 16-18). Most of the embryonal parts are organized by the derivatives of *ca* and those of *cb* form a short spread-out suspensor as in *Acalypha*.<sup>6</sup> The cells of the mature embryo are rich with starch grains, oil globules and other contents. During post-fertilization stages the inner integument develops into a massive structure and the cells of the outermost layer of the inner integument develop lignified cell-walls and form the stony layer of the seedcoat, which, in a mature seed, shows a variegated coloured pattern like the castor-seed. The fruit is a fibrous capsule. The structure of



FIGS. 1-20. Figs. 1-2. L.s. of male and female flower buds,  $\times 33$ ,  $\times 33$ . Fig. 3. Part of male flower enlarged showing the staminal column and attachment of stamens,  $\times 17$ . Fig. 4. L.s. ovule showing obturator and vascular supply into the inner integument,  $\times 33$ . Figs. 5-8. T.s. anther wall at different stages of development,  $\times 333$ ,  $166$ ,  $\times 186$ ,  $\times 166$ . Fig. 9. Pollen grain at shedding stage,  $\times 333$ . Fig. 10. L.s. young nucellus with archesporium,  $\times 333$ . Fig. 11. Parietal tissue formation and deep-seated megaspore mother cell,  $\times 333$ . Fig. 12. A linear tetrad,  $\times 333$ . Fig. 13. Mature embryo-sac,  $\times 133$ . Fig. 14. Zygote and free nuclear endosperm,  $\times 33$ . Fig. 15. A few cells enlarged of mature endosperm showing cell contents,  $\times 133$ . Figs. 16-19. Stages in development of embryo,  $\times 166$ . Fig. 20. A stage in the development of seed coat,  $\times 33$ .

the mature seed and the different stages of hypogeal germination have already been described.<sup>10</sup>

I am thankful to Mr. Raymond Tay for his technical help.

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## LETTERS TO THE EDITOR

### THERMAL EXPANSION OF HEXAGONAL SELENIUM

Two reports are available in literature from which the values of the principal coefficients of thermal expansion of hexagonal selenium can be obtained. Straumanis<sup>1</sup> gives the value of the coefficient along the *c*-axis as  $-17.89 \times 10^{-6}/^{\circ}\text{C}$ . and that in directions perpendicular to this axis as  $74.09 \times 10^{-6}/^{\circ}\text{C}$ . These are average coefficients over a small range of temperature from 15° to 60° C. Krebs<sup>2</sup> has reported the values of the lattice parameters of selenium at 20°, 130° and 210° C. The average coefficients of expansion over the range from 20° to 130° C., calculated from his data are  $-7.35 \times 10^{-6}/^{\circ}\text{C}$ . parallel to the *c*-axis and  $77.15 \times 10^{-6}/^{\circ}\text{C}$ . in perpendicular directions to this axis. While the values of the coefficient of expansion along the *a*-axis, as given by these two reports, are in fair agreement with each other, there is a large difference in the values of the negative coefficient of expansion along the *c*-axis. Although Krebs' data do not appear to be very accurate yet the difference is too large to be explained on that basis. It was, therefore, considered desirable to reinvestigate the temperature variation of the lattice parameters of selenium and try to resolve the discrepancy between the two reports and also to obtain detailed information on the temperature dependence of the coefficients of thermal expansion themselves.

Specpure beads of selenium (Johnson Matthey) were crushed to powder form and the powder of suitable grain-size was annealed at 180° C. for 48 hours. Even after this prolonged annealing the powder gave broad and diffuse X-ray diffraction lines on the back-reflection camera. Similar effect was observed by Krebs<sup>2</sup> also, who attributed it to the strains in the lattice. It was further noticed that the powder lines became sharper in pictures taken at high temperatures and broadened again when the specimen was cooled to room temperature. This reversible lattice distortion is obviously caused by thermal strains<sup>3</sup> which could not be removed completely even by careful annealing.

The experimental procedure described earlier<sup>4,5</sup> was used for determining the lattice parameters at different temperatures. The errors in the values of the two parameters were estimated on the basis of the calculation of the

standard errors<sup>6</sup> for one film and taking into account other factors such as the fall in the intensity of the lines at high temperatures and consequent reduction in the number of measurable lines. For both the parameters the percentage errors are equal to 0.02.

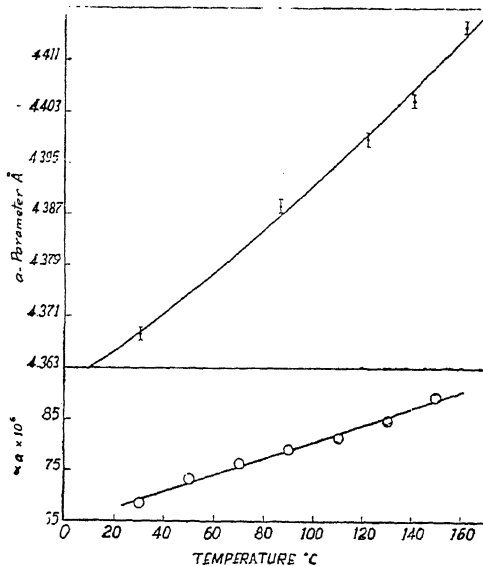


FIG. 1

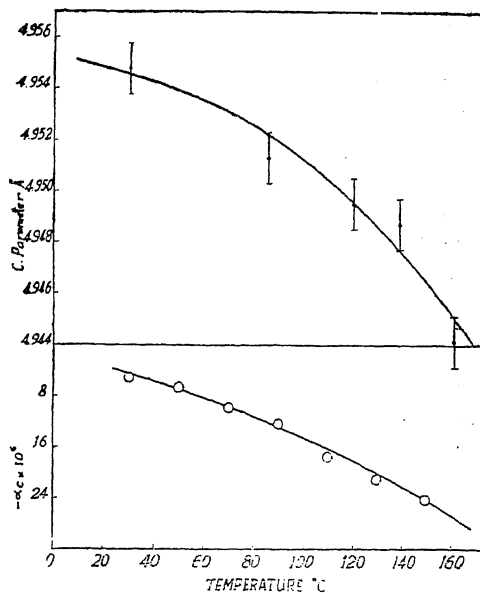


FIG. 2

Table I gives the values of the lattice parameters at five different temperatures in the range 30° to 162° C. As both the parameters show a pronounced non-linear variation with temperature (Figs. 1 and 2) the procedure recommended by Deshpande and Mudholker<sup>7</sup> was used to evaluate the coefficients of expansion of the two parameters at different temperatures. This gave the following expressions :

$$a_s = 64.69 \times 10^{-6} + 15.92 \times 10^{-8}t + 1.40 \times 10^{-12}t^2.$$

$$a_c = -1.96 \times 10^{-6} - 8.3 \times 10^{-8}t - 4.41 \times 10^{-10}t^2.$$

Here  $a_s$  and  $a_c$  are the coefficients of expansion at temperature  $t^\circ$  C. along the  $a$  and  $c$  directions respectively.

TABLE I

Lattice parameters and axial ratio of hexagonal selenium at different temperatures

Temperature °C.	$a$ Å	$c$ Å	$c/a$
30	4.3683	4.9548	1.1342
86	4.3882	4.9513	1.1283
120	4.3987	4.9495	1.1252
140	4.4040	4.9487	1.1237
162	4.4164	4.9441	1.1195

It is observed that due to the small value of the coefficient of the  $t^2$  term in the expression for  $a_s$  this coefficient of expansion exhibits almost a linear variation with temperature and that the other coefficient is negative over the whole range of temperature and shows a non-linear (numerical) increase with temperature.

For the sake of comparison with earlier reports the values of the average coefficients of expansion over two ranges of temperature, 30° to 60° C. and 30° to 130° C., were calculated. The results are as follows :

Range of temperature	$a_s \times 10^6$	$a_c \times 10^5$
30°-60° C.	72.49	-6.73
30°-130° C.	77.60	-8.38

The present value of  $a_c$  is thus found to be in good agreement with that given by Krebs<sup>2</sup> while the value of  $a_s$  is in satisfactory agreement with the earlier reports.

One of the authors (Ram Rao Pawar) is grateful to C.S.I.R. for the award of a Research Fellowship.

Department of Physics, V. T. DESHPANDE.  
University College of RAM RAO PAWAR.  
Science,  
Osmania University,  
Hyderabad-7, October 19, 1964.

Note added in Proof.—After the completion of this work the authors have come across a publication by W. Klemm *et al.* (*Angew. de*

*Chemie*, 1960, 72, 985) in which, according to the abstract available, lattice parameters of Se at different temperatures have been reported. As details of the work were not available, a comparison with it was not possible.

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### SPECTROPHOTOMETRIC STUDY OF THE REACTION OF METHINE-BIS-BARBITURATE WITH ALKALI

DURING our study on the influence of the structural factors on the kinetics of decomposition of murexide (ammonium purpurate) in acid<sup>1,2</sup> and alkaline solutions<sup>3,4</sup> we undertook investigations on methine-bis-barbiturate which has a methine (=CH-) group in place of the central nitrogen atom in the purpurate. In this connection it was noted that the interaction with alkali is not only characteristic of the methine-bis-barbiturate, but various other methines (for example those described by Claisen<sup>5</sup>) undergo change in alkaline media. Since no data exist in the literature on the kinetics and mechanism of these reactions, it was considered of value to undertake a comprehensive research programme on the subject; the present communication reports preliminary studies on methine-bis-barbiturate.

Methine-bis-barbiturate (MBB) was prepared in the form of its mono-sodium salt by following directions of Gysling and Schwarzenbach.<sup>6</sup> For this purpose barbituric acid was synthesized by the method of Biltz.<sup>7</sup> Chemicals used for buffers were of Analar grade. All the spectrophotometric measurements were made with a Beckman DU spectrophotometer fitted with a dual thermospacer set. The experiments reported here were carried out at  $25 \pm 0.1^\circ$  C.

Figure 1 gives the absorption spectrum of aqueous solution of methine-bis-barbiturate in the visible range. It is seen from the curve that there is an absorption maximum at  $\lambda = 410 \text{ m}\mu$ . This maximum was, however, shifted to higher wavelengths at higher pH (say at 11 or more) and ultimately in presence of alkali the maximum was at  $\lambda = 425 \text{ m}\mu$ . As in the case of murexide this batho-chromic effect is associated with the release of protons from the imido groups of the barbiturate. Kinetics of the reac-

tion was followed by noting the variations with time of the optical density of the system at  $\lambda = 425 \text{ m}\mu$ .

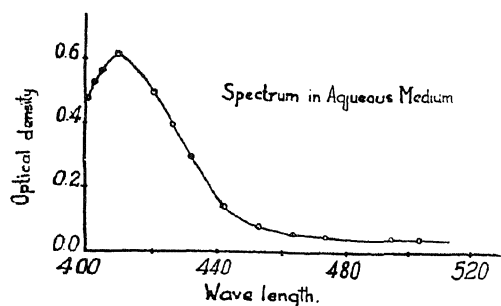


FIG. 1

TABLE I

Velocity constant of the reaction of MBB with NaOH at different concentrations of NaOH  
Temp. = 25° C.

$\lambda = 425 \text{ m}\mu$  Concentration of MBB = 0.025 mM

Concentration of NaOH mM	Apparent velocity constant $K \times 10^4 \text{ sec.}^{-1}$	Real velocity constant $K \times 10^3 \text{ litre mole.}^{-1} \text{ sec.}^{-1}$
60	0.200	0.333
80	0.257	0.321
100	0.311	0.311
120	0.371	0.309
160	0.503	0.314
200	0.619	0.310

Table I gives the values of the observed first-order rate constants corresponding to different concentrations of sodium hydroxide. The results indicate the linear dependence of the observed first-order rate constant on  $(\text{OH}^-)$ . In all the experiments reported here the concentration of NaOH was employed in much excess over that of MBB, and thus the reaction, in fact, is of second order and the value of the second-order rate constant  $K$  was obtained by the relationship,

$$K = \frac{2.303 \Delta (\log \text{O.D.})}{C_{\text{OH}^-} \cdot \Delta t}$$

and the value of  $K$  corresponds to  $0.316 \times 10^{-3} \text{ litre mole}^{-1} \text{ sec}^{-1}$ .

Grateful thanks are due to Prof. R. A. Srivastava for his kind interest, to Dr. S. K. D. Agarwal, National Sugar Institute, Kanpur, for providing facilities for spectrophotometric measurements and to Dr. R. K. Chaturvedi, H.B. Technological Institute, Kanpur, for his valuable guidance.

Department of Chemistry, D. D. MAHAJAN.  
D.A.V. College,  
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## CLEAVAGE OF ANHYDRIDES

THE cleavage of anhydrides with a number of alcohols has been studied in few solvents like acetone and dioxan. The results obtained by us are interesting in the sense that for the first time it has been observed the kinetics is of second order with respect to the anhydride, in Solvolytic experiments. It has been suggested by Satchell and Briody that in the bimolecular acylation the reaction rate is first order in both substrate and acylating agent. This communication has been necessitated by the above report of Satchell.<sup>1</sup> Our results are important in that they differ from the published work of Satchell<sup>2</sup> and Bunton.<sup>3</sup>

Our reactions have been followed in 50% solvent and 50% of alcohols (virtually a solvolytic process), with a few alcohols like methyl alcohol, ethyl alcohol, catalysed by Lewis acids like zinc chloride. The reactions have been carried out at temperatures of 40° and 45°. The rate constants are reported in Table I.

TABLE I

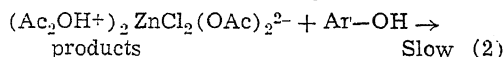
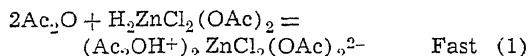
Reaction of  $\text{Ac}_2\text{O}$  with alcohols in 50% solvent  
wt. of  $\text{ZnCl}_2$  : 0.2 g.

Alcohol	Solvent	Temp.	K
MeOH	50% Acetone	45°	0.2853
	50% Acetone	40°	0.2064
	50% Dioxan	45°	0.09561
EtOH	50% Acetone	40°	0.07310
	50% Acetone	45°	0.09336
	50% Dioxan	45°	0.04176
n-Propanol	50% Acetone	40°	0.05288
	50% Dioxan	45°	0.09206
Iso Propanol	50% Acetone	40°	0.01584
	50% Dioxan	45°	0.01008

The activation energy for methyl alcohol has been calculated to be 12.76 K. calories.

The full implication of the mechanism of these reactions is not well understood; a possible explanation will be that in the rate-determining step two molecules of the anhydride form a complex with the Lewis acid, and the complex probably reacts with alcohol in a fast step to give the products.

The second order kinetics observed is quite understandable if equilibria similar to the one suggested by Satchell<sup>1</sup> are predominant.



The role of solvent is also being investigated and preliminary results indicate that the reaction rate is increased with the increase in dielectric constant. It is quite possible that in the mixture of methanolic acetone, acetone might function as a nucleophile in addition to methanol. The same situation may be present in methanolic dioxan. The study of the competitive nucleophilic character between methanol, acetone, dioxan in these cleavage reactions will be published separately. This characteristic of acetone functioning as a nucleophile is quite compatible with the similar postulates made by Snee<sup>5</sup> in his "Study of Solvolysis of Arene Sulphonates in Methanolic Acetone".

One of us (P. S. R.) thanks the National Institute of Sciences of India for the award of a Senior Fellowship.

Dept. of Chemistry, S. V. ANANTAKRISHNAN.  
Madras Christian College, P. S. RADHAKRISHNAMURTHI.  
K. S. VENKATASUBBAN.  
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### STACKING FAULTS IN DEFORMED GOLD ALLOYS

THE incidence of deformation stacking faults on the close-packed planes of a regular face-centred cubic structure as a result of plastic deformation below the recrystallisation temperature has been studied by several workers in the last decade. Although considerable amount of work has been done on several copper and silver alloys,<sup>1-5</sup> work on similar gold alloys has been rather meagre. Only one gold-cadmium alloy<sup>6</sup> and six gold-zinc alloys<sup>7</sup> have so far been examined. There is therefore a need to gather further data on gold alloys to be able to arrive at a useful correlation of the experimental data on stacking faults in the deformed alloys of

copper, silver and gold, which constitute a most interesting sub-group of the Periodic Table.

We have examined in the present work the X-ray patterns of sieved fresh filings of five gold-cadmium and five gold-magnesium alloys in the cold worked as well as annealed condition. The powder patterns obtained in a Guinier camera of the Nonius-De Wolf type with  $\text{CuK}\alpha$  radiation were all uniformly photometered in the range of the 111- and 200-reflections with the aid of a Joyce automatic recording micro-densitometer. The deformation fault parameter ( $\alpha$ ) for each alloy was determined from the change in separation between the peaks of the two reflections on cold work, as described earlier.<sup>6</sup>

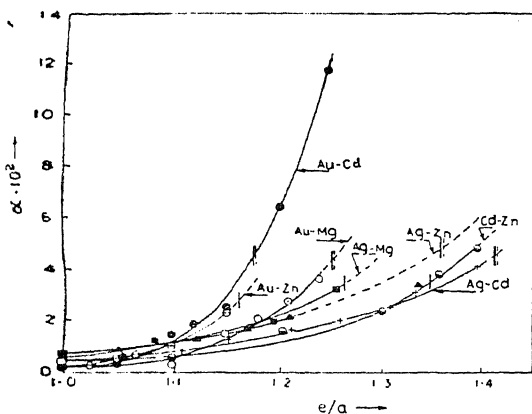
Table I presents results of our measurements

TABLE I  
Stacking faults in deformed gold alloys  
at room temperature

Au-Zn (Vassamillet <sup>7</sup> )		Au-Cd (Present work)		Au-Mg (Present work)	
At. %	$\alpha \cdot 10^2$	At. %	$\alpha \cdot 10^2$	At. %	$\alpha \cdot 10^2$
5.0	0.5	5.0	0.2	..	..
10.0	1.0	10.0	1.4	10.6	0.3
12.1	1.9	..	..	..	..
15.0	2.2	15.0	2.4	15.0	1.4
.....	.....	.....	.....	.....	.....
16.0	Alpha Limit	17.5	Alpha Limit	18.0	2.0
.....	.....	.....	.....	.....	.....
		20.0	6.4	20.0	2.7
		25.0	11.8	24.0	3.8
				.....	.....
				25.0	Alpha Limit

for gold-cadmium and gold-magnesium alloys along with the available data for gold-zinc alloys.<sup>7</sup> The maximum possible concentration of the f.c.c. phase in these alloy systems<sup>8</sup> is also mentioned in this table. The trend in the variation of  $\alpha$  with the concentration of the solute element is not comparable, although all the solute elements, namely zinc, cadmium and magnesium, are divalent. Figure 1 highlights this apparent anomaly also for all copper and silver alloys so far investigated with divalent solute elements, viz., copper-zinc,<sup>1</sup> silver-zinc, silver-cadmium and silver-magnesium.<sup>3</sup> Some order emerges in this picture, however, when the equilibrium saturation concentration of the solute element is considered along with the nature of the next intermediate phase in the relevant binary system. When the f.c.c. phase is followed by the closely similar hexagonal close-packed or a slightly distorted version of either close-packed structure as in the silver-cadmium,

silver-zinc, gold-cadmium<sup>9</sup> and gold-magnesium<sup>10</sup> systems,  $\alpha$  seems to reach the same value ( $\sim 0.05$ ) at the phase boundary. In other cases, where the second phase happens to be different,  $\alpha$  seems to attain a lower value ( $\sim 0.03$ ) at the saturation limit. Values of  $\alpha$  higher than 0.05 are obviously possible (Table I) in the former category when the solute concentration exceeds the maximum for the f.c.c. phase, but cold work converts the two-phase annealed alloy to a faulted f.c.c. structure.



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Max-Planck-Institut M. K. MUKHERJEE.\*  
für Metallforschung, T. R. ANANTHARAMAN.†  
Stuttgart-N, West Germany,  
December 7, 1964.

\* Now at Midwest Research Institute, Kansas City, U.S.A.

† Now at the Department of Metallurgy, Banaras Hindu University, Varanasi-5.

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## ALKALOIDS FROM FRUITS OF *ALANGIUM LAMARKII* (THWAITES)

THE present communication describes the isolation of two pure alkaloids from the fruits of *Alangium lamarkii* (Thwaites) which belongs to the family Cornaceae and is known in vernacular as "Ankola". It is a straggling shrub or a small tree, nearly evergreen, with or without thorns. It is distributed throughout different parts of India. The fruit is ellipsoid, smooth, pubescent and 0.75 in. long, whereas the seeds are embedded in a soft pulp. The fruit is edible and is useful in burning of body, consumption and hæmorrhages.<sup>1</sup>

The powdered fruits (3 kg.) were extracted with ether and the ether layer divided into basic, neutral and acid portions. Extraction of the basic portion with chloroform, yielded after evaporation of the solvent, a light brown coloured solid (12 g.), which was a mixture of alkaloids.

A thin layer chromatogram of this mixture over silica gel using chloroform-methanol phase and spraying with Dragendorff reagent gave four spots showing the presence of four alkaloids, having the  $R_f$  values (22°) 0.15, 0.35, 0.56 and 0.62.

Chromatography of about 4 g. of the alkaloid mixture over alumina yielded, on elution with benzene, about 1 g. of a solid which after repeated crystallisations from dilute alcohol gave colourless needles, m.p. 223–24°.  $[\alpha]_D^{25} = -18.3^\circ$  ( $C = 1.57$ ). The mol. wt. by mass spectrum was found to be 459 (Found: C, 75.34, 75.6; H, 8.28, 8.1; N, 9.0, 8.96; H, 0.2; C, CH<sub>3</sub>, 3.79; -OCH<sub>3</sub>, 14.18; C<sub>29</sub>H<sub>37</sub>O<sub>2</sub>N<sub>3</sub> requires C, 75.78; H, 8.11; N, 9.14; H, 0.22 2 -OCH<sub>3</sub>, 13.51%).

The U.V. spectrum of the alkaloid in alcohol showed  $\lambda_{max}$ , 280 m $\mu$  ( $\log \epsilon$ , 4.05) and  $\lambda_{max}$ , 226 m $\mu$  ( $\log \epsilon$ , 4.58).

The I.R. spectrum shows the following characteristic bands: at 2.97  $\mu$  the NH-band of an indole or carbazol; at 3.50  $\mu$  and 3.63  $\mu$ , bands of N-alkyl C-H; at 6.21  $\mu$  and 6.63  $\mu$  bands of aromatic or heteroaromatic nuclei; at 8.04  $\mu$ , 8.75  $\mu$  and 9.12  $\mu$  bands of aromatic ether groups; at 11.65  $\mu$  a band coming possibly from a para-disubstituted or a 1, 2, 3, 4-tetra-substituted benzene and finally at 13.48  $\mu$  a band coming probably from an orthodisubstituted benzene.

The above alkaloid failed to give any of the characteristic salts in a crystalline condition. It did not give a positive test with Ehrlich reagent. It gave a positive test characteristic

of a tetrahydro- $\beta$ -carboline system,<sup>2</sup> namely, the development of a bluish-green colour at the zone of contact between concentrated sulphuric acid containing a few drops of 0.5% sodium nitrite solution and an acetic acid solution of the alkaloid.

On treatment with acetic anhydride at room temperature, this alkaloid gave a solid which after repeated crystallisations from ligroin had m.p. 158–60°.

From the above chromatogram over alumina, elution with benzene-ether mixture (3 : 1) gave about 1 g. of a solid which failed to give a pure substance on crystallisation. On heating it with formaldehyde and formic acid as described by Subbaratnam<sup>3</sup> a semi-solid product (0.6 g.) was isolated which when passed over a column of alumina gave, after elution with benzene, a pale yellow solid (0.4 g.) which was crystallised from dilute alcohol in colourless prisms, m.p. 190–91°.  $[\alpha]_D = -50.4$  ( $C = 1.14$ ). (Found: C, 72.25; H, 8.2; N, 6.1). The U.V. spectrum showed  $\lambda_{\text{max}}^{\text{alcohol}}$  282 m $\mu$  (log  $\epsilon$ , 3.85) and 217 m $\mu$  (log  $\epsilon$ , 4.2). Its I.R. spectrum showed the following bands 3.45  $\mu$  (OH), 6.22  $\mu$ , 6.57  $\mu$ , 6.63  $\mu$  (aromatic), 8.01, 8.84, 9.93  $\mu$  (aromatic ether) and at 11.65  $\mu$ , 13.03  $\mu$  (aromatic out-of-plane vibration). This alkaloid, which was reported by Subbaratnam<sup>3</sup> as Alamarkin, has been identified recently<sup>4,5</sup> as N-methyl cephaelin.

From the neutral portion of the ether extract, a large amount of a waxy material was obtained which after chromatography over alumina yielded a solid which after three crystallisations from dilute alcohol gave colourless prisms, m.p. 288–89° (Found: C, 76.55; H, 10.90; N, 0.34;  $-\text{OCH}_3$ , nil).

It gave positive Liebermann-Buchand and Salkowski tests indicating it to be sterol.

Further work on the structure of the alkaloid is in progress and will be reported elsewhere.

We are thankful to Prof. P. V. Bole, Head of the Botany Department, St. Xavier's College, Bombay, for collecting and identifying the plant material. We also thank Dr. L. Chopard, Basle, Switzerland, for taking I.R. spectra and to Prof. V. Prelog, Zurich, for mass spectrum.

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Bombay-1, December 28, 1963.

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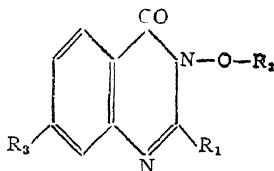
### 3-HYDROXYQUINAZOLIN-4-ONES AND THEIR DERIVATIVES

THE following 3-hydroxy-3, 4-dihydroquinazolin-4-ones and their derivatives were synthesised during the course of our investigations on the quinazolin-4-one system. 3-Hydroxy-3, 4-dihydroquinazolin-4-ones reported in this communication were synthesised by the action of hydroxylamine on the corresponding 4H-3, 1-benzoxazin-4-ones, in aqueous or alcoholic medium. The alkoxy and arylalkoxy derivatives were prepared by the reaction of 3-hydroxyquinazolinones with alkyl and arylalkyl halides. Some typical experiments are described below.

**2-Methyl-3-hydroxy-3, 4-dihydroquinazolin-4-one.**—Hydroxylamine hydrochloride (23 g.; 0.33 mole) was taken in absolute ethanol (400 ml.); sodium methoxide (18 g.; 0.33 mole) in ethanol (100 ml.) was added to the former and refluxed for 1/2 hour. To the solution of hydroxylamine in ethanol thus obtained was added 2-methyl-4H-3, 1-benzoxazin-4-one (54 g.; 0.33 mole) and left overnight at room temperature. It was subsequently refluxed for 1/2 hour and filtered hot. The filtrate was concentrated to half its bulk and allowed to cool when the title product crystallised out; it was crystallised from ethanol; m.p. 207–8° (reported<sup>1</sup> m.p. 214°). Found: N, 16.30; Calc. for  $\text{C}_9\text{H}_8\text{N}_2\text{O}_2$ : N, 15.92%.

**2-Methyl-3-*w*-dimethylaminopropyloxy-3, 4-dihydroquinazolin-4-one dihydrochloride.**—2-Methyl-3-hydroxy-3, 4-dihydroquinazolin-4-one (1.76 g.; 0.01 mole), anhydrous potassium carbonate (8.3 g.; 0.06 mole) and *w*-dimethylaminopropyl chloride hydrochloride (3.16 g.; 0.02 mole) were refluxed for four hours in acetone (100 ml.). At the end of the reaction, the solvent was distilled off and the residue was diluted with water and extracted with benzene ( $2 \times 20$  ml.). The benzene extract was washed with sodium hydroxide solution (5%; 20 ml.) and then with water; it was later dried over sodium sulphate and concentrated to a small volume (ca. 5 ml.). To the concentrated benzene solution of the quinazolinone was added propanolic hydrochloric acid (6N; 3.4 ml.) when a crystalline solid was obtained; it was crystallised from ethanol; m.p. 195–6°. Found: N, 12.58; Calc. for  $\text{C}_{14}\text{H}_{21}\text{N}_3\text{O}_2\text{Cl}_2$ : N, 12.57%.





No.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	m.p. °C.	lit, m.p. °C.	Nitrogen % Found	Calculated
I	CH <sub>3</sub>	H	H	207-8	214 <sup>1</sup>	16.30	15.92
II	CH <sub>3</sub>	CH <sub>3</sub>	H	91-2		14.42	14.73
III	CH <sub>3</sub>	C <sub>6</sub> H <sub>5</sub>	H	62-3		13.49	13.73
IV	CH <sub>3</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	H	109-10	114 <sup>2</sup>	10.27	10.53
V	CH <sub>3</sub>	(CH <sub>3</sub> ) <sub>2</sub> N(CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> : 2HCl	H	195-6		12.58	12.57
VI	C <sub>2</sub> H <sub>5</sub>	H	H	144-5		14.78	14.73
VII	C <sub>2</sub> H <sub>5</sub>	CH <sub>3</sub>	H	85-6 <sup>2</sup>		13.74	13.73
VIII	C <sub>2</sub> H <sub>5</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	H	103-4		10.04	10.00
IX	C <sub>2</sub> H <sub>5</sub>	(CH <sub>3</sub> ) <sub>2</sub> N(CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> : 2HCl	H	95-102*		12.40	12.07
X	C <sub>2</sub> H <sub>5</sub>	H	Cl	169-70		12.41	12.47
XI	C <sub>2</sub> H <sub>5</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	Cl	114-6		8.64	8.90
XII	C <sub>2</sub> H <sub>5</sub>	(CH <sub>3</sub> ) <sub>2</sub> N(CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> : 2HCl	Cl	164-6		11.20	10.97
XIII	CH <sub>3</sub>	H	NO <sub>2</sub>	232-4	237 <sup>2</sup>	19.24	19.00
XIV	CH <sub>3</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	NO <sub>2</sub>	186-8	194 <sup>2</sup>	13.31	13.50

\* The material is hygroscopic and the melting point is not sharp.

**2-Ethyl-3-hydroxy-3, 4-dihydroquinazolin-4-one.**—To an aqueous solution of hydroxylamine, obtained from hydroxylamine hydrochloride (4.2 g.; 0.06 mole) and potassium carbonate (8.3 g.; 0.06 mole) in water (20 ml.), was added 2-ethyl-4 H-3, 1-benzoxazin-4-one (3.5 g.; 0.02 mole) and heated with stirring at 60° for 1 hour. The reaction mixture was cooled and, after adjusting the pH to 6.5 with acetic acid, filtered. The solid was crystallised from aqueous ethanol to obtain 2-ethyl-3-hydroxy-3,4-dihydroquinazolin-4-one melting at 144-5°. Found: N, 14.78; Calc. for C<sub>10</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>: N, 14.73%.

**2-Ethyl-3-benzoyloxy-3, 4-dihydroquinazolin-4-one.**—2-Ethyl-3-hydroxy-3, 4-dihydroquinazolin-4-one (1.9 g.; 0.01 mole), potassium carbonate (6.9 g.; 0.05 mole) and benzyl chloride (1.9 g.; 0.015 mole) were refluxed in acetone (100 ml.) for 5 hours. The reaction product was stripped of acetone and, after dilution with water, extracted with benzene (3 × 10 ml.). The benzene extract was dried over sodium sulphate; benzene was distilled off and the residue was crystallised from heptane to obtain 2-ethyl-3-benzoyloxy-3, 4-dihydroquinazolin-4-one melting at 103-4°. Found: N, 10.04; Calc. for C<sub>17</sub>H<sub>16</sub>N<sub>2</sub>O<sub>2</sub>: N, 10.00%.

Scientific and Technical S. SOMASEKHARA.  
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Baroda, August 10, 1964. S. L. MUKHERJEE.

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## STUDIES ON THE HETEROKARYOTIC VIGOUR IN THE DECOMPOSITION OF RIBOFLAVINE

DURING our studies on the accumulation of riboflavine intermediates, it was observed that a green compound is formed in the cultures of the heterokaryons produced between a pair of non-allelic riboflavine requiring mutants of *Aspergillus nidulans*. The formation of such a green compound does not take place when the mutant strains are grown individually. Probably this is the first observation of heterokaryotic vigour noticed in mutant strains of *Aspergillus nidulans*. An attempt has been made to study the formation of the green compound which is reported here.

The five non-allelic riboflavineless mutants are found to require riboflavine for growth due to gene mutations at different loci, wherein different enzymes participating in the biosynthetic pathway are affected. They are obtained with three different spore colours, white and yellow mutants produced from the green wild type. The green non-requirer can grow in a medium,<sup>1</sup> consisting of minerals and glucose as

the sole carbon source. The riboflavineless mutants are grown in this medium supplemented with 100  $\mu$ g. of the vitamin per litre. The heterokaryons are made identifiable by taking pairs of mutant strains with different spore colours.

White ribo<sub>0</sub> and yellow ribo<sub>6</sub> are grown as mixed inoculum in complete medium<sup>1</sup> and the balanced heterokaryotic spores formed are inoculated into carboys containing 3 litres of sterile minimal medium and kept for incubation at room temperature. At the end of two weeks, a patch of green granules is observed on the mycelium. This is found to be different from the green diploid that may be produced from a combination of yellow and white mutants. On standing for three weeks, the green patch is found to spread over the surface and the culture broth turned green in colour from the original light brown colour. On transplanting to the agar plates containing minimal medium supplemented with riboflavine (this will enhance segregation of the two strains forming the heterokaryon), white and yellow segregants have been observed and the green granules turned orange red in six to eight weeks. The green shade observed in the granules are found to be different from the colour of the wild type-spore colour green and this forms a green solution. A chemical examination of this compound has been undertaken.

A portion of the green material is dissolved in 4N potassium hydroxide and centrifuged to remove the cell debris. This on treatment with 10N sulphuric acid gave a gelatinous green precipitate, which on filtering on a Buchner funnel and keeping overnight turned orange red. Also, a portion of the green solution, when treated with ethyl acetate, on slow hydrolysis led to acidification and after 48 hours gave a crop of orange-coloured crystals having an absorption maxima at 274 m $\mu$  and 320.5 m $\mu$  at acid pH, with a yellow fluorescence in ultra-violet light, but could be separated from riboflavine by paper chromatography with butanol-acetic acid-water as solvent and is identified as isoalloxazine compound.

An alkaline solution of the green compound purified by washing with methanol and acetone is treated with a solution of sodium hydro-sulphite, when a dark green precipitate was obtained. This green substance on treatment with concentrated sulphuric acid gave a bright red solution, which when left in a china dish kept open, after dilution, gave the original green colour.

The colour changes observed herein correspond with the quinoxaline-like complex system<sup>2</sup> involving the partially reduced and reduced molecules, chloroflavin (light green), verdo-flavin (dark green) and rhodoflavin (red). Similar observations have been made by Miles and Stadtman<sup>3</sup> in the case of riboflavine decomposing bacteria and the flavin involved has been identified as 6, 7-dimethyl, 9 (2'-hydroxy ethyl)-isoalloxazine, which has been reported as a metabolite of riboflavine in goats.<sup>4</sup>

These observations point to show that a type of fermentation of the vitamin riboflavine exists in the heterokaryons, which is not present in the individual mutant strains and this may be attributed to the phenomena of heterokaryosis and the vigour attached to such a state. A study of the enzymes responsible for the riboflavine fermentation will be highly interesting and is in progress.

Univ. Biochem. RADHA SHANMUGASUNDARAM.  
Department, E. R. B. SHANMUGASUNDARAM.  
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### PAIRED MEDULLA IN HUMAN HAIR

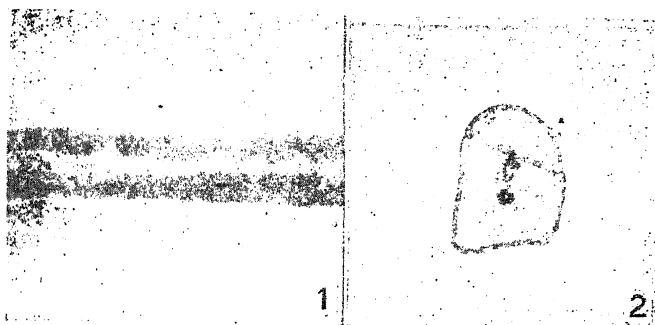
DURING the course of our study with hair we have encountered a sample of human beard showing paired medulla on microscopical examination. This appears to be an unusual variation in the normal histology of human hair. So far we are not aware of any report regarding such histological variability of medullary structure in human hair.

Incidentally it is obvious that such a singular anomaly will be very useful in the individualisation of human hair.

The photomicrographs (Figs. 1-2) reproduced here pertain to a sample of beard hair from an adult Indian. On microscopical examination, the strands of hair were divided into three categories on the basis of their medullary character studied in intact hair and also in serial cross-sections.

*Category I.*—Hair with usual single medulla passing through the centre of the cortex. Most of the strands of hair belonged to this category.

*Category II.*—Hair with paired medulla along the entire length (Figs. 1 and 2). Six per cent. of the strands of hair belonged to this category.



FIGS. 1-2. Fig. 1. Intact hair showing paired medulla. Fig. 2. Cross-section showing paired medulla.

**Category III.**—Hair with paired medulla at some places only. Fourteen per cent. of the strands of hair belonged to this category.

We are thankful to Dr. N. K. Iyengar, Director, for his interest and to Mr. R. C. Banerjee for the photomicrographs.

Biology Division, S. CHOWDHURI.  
Central Forensic Sci. Lab., B. BHATTACHARYYA.  
Government of India,  
Calcutta, September 19, 1964.

# EFFECTS OF PHENFORMIN (DBI) ON THE SURVIVAL TIME OF RATS SUBJECTED TO RAREFIED ATMOSPHERE SIMULATING HIGH ALTITUDE

FEEDING of carbohydrate diet to mice subjected to a rarefied atmosphere simulating a high altitude of about 33,000 feet has been reported to increase the survival time of mice very significantly.<sup>1</sup> This beneficial effect of carbohydrates seems to be related to the synthesis of ATP through glycolysis, in view of the fact that sodium iodoacetate, which specifically inhibits the glycolysis, has been reported to rapidly decrease the ATP concentration in brain and at the same time markedly reduce the survival time.<sup>2</sup> Since the biguanide derivative-N beta phenethyl biguanide hydrochloride (Phenformin) has been reported to promote intracellular glycolysis and help in insulin transport mechanisms,<sup>3</sup> but at the same time reduce the oxygen consumption of tissues,<sup>4</sup> it would be worthwhile to investigate its effect on the survival time of rats subjected to hypoxic condition.

Adult albino rats, weighing between 150 and 185 gm. and fed on stock diet, were distributed into three groups, so as to have a rat of equivalent weight in each. Rats of Group I were given distilled water only to serve on control while Groups II and III rats were administered

aqueous solution of Phenformin in 2 mg./Kg. doses through stomach tube. Glucose 25% solution (20 ml./Kg.) was also fed orally to Group III animals together with the drug. Two hours after oral feeding, the individual rats were subjected to low atmospheric pressure (520 mm. of Hg barometric pressure, simulating an altitude of 10,000 feet) in a closed vacuum desiccator of one litre capacity. The glass chamber was connected to a vacuum pump and the pressure was recorded by a mercury manometer. The chamber was kept at low temperature (18° C.) in the lower compartment of a refrigerator. Respiratory rate counted from the costo-abdominal movement per minute was noted every 5 minutes, through a perspex window in the refrigerator. Time of onset of asphyxia or dyspnoea was observed by the movement of alae nasi, and ultimately time of death was noted on complete cessation of respiration.

The survival time of rats in each group is given in Table I.

TABLE I  
Showing the effect of Phenformin  
on survival time of rats subjected to low  
atmospheric pressure

Survival time (in minutes) of rats in the following groups

Av. body weight in each set	Group I (Control)	Group II (Drug-treated)	Group III (Glucose fed and drug-treated)
183.00 ± 2.64	15.81	26.00	34.12
155.33 ± 2.52	23.04	26.49	37.52
158.66 ± 6.02	24.02	27.63	38.51
177.66 ± 2.51	18.40	25.52	32.61
168.66 ± 12.4	20.99 ± 2.93	26.41 ± 0.91	35.76 ± 2.89

In general, the time of onset of asphyxia was delayed and the survival time was found to be

more ( $26.41 \pm 0.91$  minutes) in drug-treated rats as compared to the controls ( $20.99 \pm 2.93$  minutes). This difference was found to be quite significant ( $P < 0.05$ ). Increase in the survival time of Group III rats fed glucose together with the drug was even more marked ( $35.76 \pm 2.89$  minutes) and highly significant ( $P < 0.001$ ).

From the above, it would be apparent that the biguanide derivative Phenformin (DBI) significantly increased the survival time of rats in hypoxic condition. This effect may be attributed either to the inhibitory effect of the drug on the oxidative metabolism and thus reducing the oxygen requirements of the body, or to its favourable effect on ATP synthesis through glycolysis which needs to be further investigated.

Dept. of Pharmacology, S. S. GUPTA.  
Gandhi Medical College, R. P. BHARGAVA.  
Bhopal (M.P.), India, M. K. KHATTRI.  
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### OCCURRENCE OF COQUINITE IN THE SUBATHU BEDS (LAKI-EOCENE)

THE so-called "shelly limestones" described by Auden (1934) and others from the Subathu beds of the Simla Hills of the Himalayas have been identified as true "Coquinites", as they conform to the modern sedimentological terminology used for similar rocks. According to Carozzi (1960), coquinite is "a fully cemented limestone containing at least 50% of mechanically deposited mollusc shells or shell fragments".

During the course of investigation of the Subathu in the type area and in the Malla area of the Simla Hills the author encountered several bands of coquinite varying in thickness from 5' to 40'.

Megascopically the rock is dirty grey, hard and compact, showing broken fragments of pelecypod and gasteropod shells. Besides these, isolated ostracod shells are also seen in thin section. The cementing material of the fragments is an admixture of calcareous and argillaceous matrix. The shell fragments of the

coquinite are highly broken and crushed suggesting an allochthonous origin of the rock.



FIG. 1. Photomicrograph of coquinite showing shell fragments.

Detailed work on the sedimentology of the Subathu rocks of the type area is in progress and will be published in due course.

Department of Geology, A. D. KHARKWAL.  
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### A NOTE ON THE OCCURRENCE OF ALGAL STROMATOLITES IN VINDHYAN LIMESTONE FROM BILARA, DISTRICT JODHPUR, RAJASTHAN

WHILE examining the area near Bilara ( $73^{\circ} 43' : 26^{\circ} 11'$ ) the author came across many laminated structures in the limestone and dolomitic limestone which had hitherto not attracted any special attention of the previous workers.<sup>1</sup> These structures are typically stromatolitic and are well exhibited around Kharia, and other villages. They are also prominently seen along the embankment of the Jaswant Sagar tank about two miles north-east of Bilara. The recognition of such organosedimentary structures in the limestone member of the Trans-Aravalli Vindhyan basin, which is generally believed to be unfossiliferous, has great importance.

The important genera forms observed in this area are *Collenia* and *Cryptozoon*. The *Collenia* is characterised by discrete or laterally linked hemispheroid bodies (Fig. 1), sometimes spheroidal, composed of concave-convex laminae, while the *Cryptozoon* is distinguished by discrete, club-shaped or columnar structure com-

posed of vertically stacked hemispheroids, expanding upward from base (Fig. 2).



FIGS. 1-2

The discovery of stromatolite structures has indicated that the deposition of limestone took place in the inter-tidal or near the inter-tidal zones.

The author desires to express his thanks to Mr. Y. N. Dave, Senior Geologist, and to Mr. R. B. Nag, University of Jodhpur, for their valuable suggestions.

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# **HAUSMANNIA CROOKSHANKI SP. NOV. FROM JABALPUR SERIES OF INDIA\***

The first record of *Hausmannia* in India was made by H. Crookshank<sup>1</sup> in 1935 from the Jabalpur series in Satpura Gondwana basin of Madhya Pradesh from where he recorded *Hausmannia dichotoma* Dunker and *H. cf. buchii* Indrae. K. M. Gupta<sup>2,3</sup> reported *H. indica* Gupta from Rajmahal series of Bihar. C. Nageswara Rao and S. C. Shah<sup>4,5</sup> recorded *Hausmannia* sp.

from Kota-Maleri beds and *H. cf. buchii* and *Hausmannia* sp. from Chikiala sandstones of Pranhita-Godavari basin. These are the only known reported occurrences in India so far.

The authors in 1964 while examining the Jabalpur series collected a few specimens of *Hausmannia* from Jatamao, the same locality as that of Crookshank. The collection includes, besides *H. dichotoma*, a new species of *Hausmannia* which is being reported in this note.

## **DIPTERIDACEAE**

GENUS : *Hausmannia*, DUNKER 1846  
*Hausmannia crookshanki* sp. nov.



FIG. 1. *Hausmannia crookshanki* sp. nov.,  $\times 1$ .

The frond is probably petiolate. The lamina is broadly reniform in outline and has a diameter of 4.5 cm. At the base of the lamina, there is a deep sinus reaching nearly the centre. Eight primary nerves radiate from the bottom of the sinus, branching dichotomously once or twice and reach the margin of the lamina. From these primary nerves finer nervelets are given off approximately at right angles. The nervelets subdivide and unite into narrow square or polygonal meshes arranged more or less regularly. The margin of the lamina is almost entire. No sori are seen.

Locality : On the cart tract 0.8 km. east of Jatamao ( $22^{\circ} 23' : 77^{\circ} 35'$ ).

Horizon : Jabalpur series.

Age : Upper Jurassic.

Holotype : G.S.I. Type No. 18122.

Remarks.—The species is represented by a single but well-preserved specimen in counterparts. It agrees in many characters with the eastern species, *Hausmannia nariwaensis* Oishi,<sup>6</sup> from the Rhaetic beds of Nariwa, Japan. However, the new species differs from *H. nariwaensis* in the absence of sori, overlapping of laminal portion and having comparatively coarser meshes. It also differs from the other known

species. Hence a new specific name has been proposed for the present form, named after Dr. H. Crookshank, a pioneer worker in the Gondwana geology of Satpura basin and who recorded this genus for the first time from India.

The genus *Hausmannia* has a maximum record in Jabalpur series of Satpura basin, though its presence has been noted in the Pranhita-Godavari and Rajmahal basins also. Further search may throw light on the history of evolution and migration of the family Dipteridaceæ.

The authors are thankful to Mr. M. V. A. Sastry, Palæontologist-in-Charge, Geological Survey of India, for his valuable suggestions.

Central Palæontological Labs., S. C. SHAH.  
Geological Survey of India, GOPAL SINGH.  
Calcutta, August 6, 1964.

\* Published with the kind permission of Director-General, Geological Survey of India.

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#### STUDIES ON THE LIFE-HISTORY OF *ORIENTOBILHARZIA TURKE- STANICUM* (SKRJABIN, 1913) DUTT AND SRIVASTAVA, 1955 (PRELIMINARY REPORT)

*Orientobilharzia turkestanicum* (Skrjabin, 1913) Dutt and Srivastava (1955) was first described by Skrjabin (1913) from cattle in Russian Turkestan. Marotel (1908) reported its occurrence in a cow in France and Popov (1926) recorded its presence in a cat in Kazakstan. The blood-fluke has since been reported to occur in Mongolia (Yamagiwa, 1931), Iraq (MacHattie and Chadwick, 1932), Pakistan (Abdussalam and Sarwar, 1953) and India (Srivastava and Trisal, 1957). As regards its definitive host range and incidence, MacHattie (1936) reported that in the Amarah-Basrah areas of Iraq about 80% of sheep, goats, cattle and water-buffaloes were infected as also about 15% of horses, donkeys, mules and camels. Its incidence in certain species of domestic ruminants in India (Kashmir) was found to be quite high (Dutt and Srivastava, 1963).

As the life-history of this important blood-fluke, *O. turkestanicum*, has hitherto been only

imperfectly known, studies were undertaken to elucidate it more fully.

The material for these studies was originally collected from a village near Srinagar during two visits in October 1960 and 1962. Faecal samples of cattle, sheep and goats were examined by the hatching technique for miracidia in order to infect local species of aquatic snails. The latter were also examined for natural infection with schistosome cercariae. The naturally and experimentally infected snails were brought to Izatnagar; cercariae shed by them were studied and definitive hosts were subjected to experimental infection. The animals, which proved to be susceptible to experimental infection, furnished material for further studies.

The miracidium of *O. turkestanicum* measures 85–134  $\mu$  in length and 31–61  $\mu$  in maximum width. Its epidermal cell formula is 6 : 9 : 4 : 3. There are six anterior papillae, two pairs of 'lateral papillae' and two sets of 'bristle patches'—the second set containing 15–18 (mostly 16) bristle patches. There are a pair of penetration glands, an apical gland, a central nerve mass, two lateral excretory canals each with a pair of flame cells, and a number of germinal cells.

The cercaria of *O. turkestanicum* is apharyngeal, brevifurcate and non-ocellate. The furcal rami are without fin-folds. When viewed in clear water in a glass container, the cercariae can be seen easily with the naked eye. In shade they congregate near the surface of the water, in strong sunlight they sink to the bottom and in mild sunlight they remain uniformly distributed throughout the water. The dimensions of the cercaria are as follows: body length 144–199  $\mu$ , maximum body width 40–62  $\mu$ , tail stem length 165–248  $\mu$ , tail stem width 23–39  $\mu$ , length of furcal rami 53–115  $\mu$ , length of head organ 44–58  $\mu$ , width of head organ 29–35  $\mu$  and diameter of acetabulum 21–25  $\mu$ . The alimentary system consists of a ventral mouth, a narrow oesophagus and a bilobed caecum. There are five pairs of penetration glands. The flame cell formula is  $2[2+2+(1)]$ . The dilation in connection with the excretory opening is situated well within the margin of the tip of the furcal ramus.

*Lymnaea auricularia* serves as the natural intermediate host of *O. turkestanicum* in the endemic area near Srinagar. The race of the snail is referable to *Lymnaea auricularia sensu stricto* of Hubendick (1951). The same race has also been found to be highly susceptible to experimental infection. *L. auricularia* race



myna, in the Bank myna it is a little more difficult since the difference in length between the upper beak of the male and female is not so great as in the crow. Of the mynas of the same beak length, it is difficult to say whether they are of one sex or the other: therefore, I have provided beak length from the anterior and also the posterior rim of the anterior nostril after clearing the cere (Table I). In the male the upper jaw length is longer than in the female. I have found that by remembering the normal length of the male beak and measuring the same in the unsexed bird, I am able to correctly identify the sex of the bird. This indicator may not be applicable in the case of juveniles where there may be a certain overlap of the beak length but is infallible in the weight range mentioned in Table I.

TABLE I

Name	Sex and No. examined	Average weight of bird in gm.	Length in mm. from	
			Anterior tip of nostril to tip of upper beak	Posterior tip of nostril to tip of upper beak
House crow	73 male	273	35	40
( <i>C. splendens</i> )	45 female	192	30	32
Common myna	17 male	81	17	20
( <i>A. tristis</i> )	11 female	69	14	16
Bank myna	25 male	70	16	19
( <i>A. gingivina-mus</i> )	17 female	53	15	18

Probably in many other birds this method could be employed when there are no other sex differentiating characters, if the beaks show differential growth.

Department of Zoology, D. K. Vyas.  
University of Rajasthan,  
Jaipur, India, September 14, 1964.

#### COSSURA COASTA KITAMORI (POLYCHAETA: COSSURIDAE); A NEW RECORD FROM INDIAN WATERS

The genus *Cossura* was previously included in the family Cirratulidae, but it differs from typical cirratulid genera in several important characters that Day<sup>1</sup> has suggested its inclusion in a new family, Cossuridae. The genus is known through five species: *C. longocirrata* Webster and Benedict,<sup>2</sup> *C. candida* Hartman,<sup>3</sup> *C. pygodactylata* Jones,<sup>4</sup> *C. delta* Reish<sup>5</sup> and *C. coasta* Kitamori.<sup>6</sup> None of these species has been previously recorded from Indian waters. *C. coasta* was first described and reported from

the Seto-Inland Sea, and later it has also been recorded by Day from the sea off Cape Province, S. Africa. Among the collections of polychaetes obtained off the coast of Kerala by R. V. Conch were six cossurid specimens which, as described briefly below, show great resemblance to the African specimens.

December 17, 1959, Station 187 off Beypore, 11° 08' N. : 75° 43' E, Depth 9m, Bottom—greenish mud, 6 incomplete specimens from dredge.

**Description.**—The largest specimen measures 4.2 mm. by 0.4 mm. for 38 segments. The prostomium is clearly demarcated and is a depressed cone, slightly longer than broad. The first two segments are apodous, with the second larger than the first segment. Distinct parapodial lobes are absent, but setae arise from slight elevations of the lateral body wall. In the first setiger, setae are set together to form a single bundle, but from the second setiger onwards, setae are in two separate bundles. A single, long, slender gill arises from the anterior part of the third setigerous segment in the mid-dorsal line. The gill is constricted towards its point of attachment, and appears annulated due to wrinklings of its surface epithelium. In each setiger, setae are arranged in two rows, both in the notopodium and the neuropodium, with an anterior row of shorter and a posterior row of longer setae. There are 10–12 simple capillary setae per setiger, each with rows of spinelets marginally. The spinelets arise in oblique rows and give a finely striated appearance to the blade portion of the setae. In none of the specimens is the proboscis everted. The nature of the pygidium could not be ascertained since all the specimens lacked the terminal segments.

As shown above, the present specimens resemble very closely those described from the African coast by Day as *C. coasta*, though specific differences between *C. coasta* and the American species *C. candida* are slight. As in the African specimens, a posterior row of longer setae arises from each ramus, though in the type species of *C. coasta*, as also in *C. candida*, longer setae are confined to the notopodium. Day suggests that the characters relied upon by Reish for differentiating species of *Cossura* are somewhat slender evidence for specific identification. The five species so far described may therefore be in need of revision; the African and Indian specimens though agreeing better with the description of *C. coasta* than of *C. candida* appear to be closer to each other and may represent a variant of the Japanese species.



Oceanographic Laboratory, P. J. THOMAS.  
University of Kerala,  
Eranakulam-6, August 14, 1964.

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# COLCHICINE-INDUCED POLYPLOIDY IN *TORENIA FOURNIERI* LIND.

*Torenia fournieri* Lind. is an ornamental plant grown during the rainy season for its showy bluish-white flowers. The results of an attempt made to bring about an improvement in this ornamental plant through polyploidy breeding are reported in the present note.

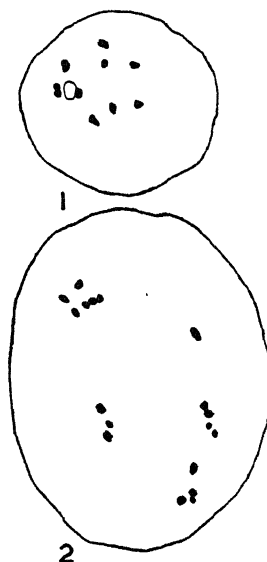
The apical growing points of the young seedlings with four to six leaves were treated with 0.05, 0.10 and 0.20% colchicine for 10 and 20 hours. The most effective treatments were found to be 0.10 and 0.20% colchicine applied for 20 hours. The flower-buds were fixed in Carnoy's fixative. The squashes of pollen mother cells were stained with propionocarmine. The observations on the colchicine-treated plants were restricted only on such shoots which, on the basis of chromosome determination, were found to be at tetraploid level. The leaves borne on the tetraploid shoots were dark green and slightly thicker in comparison with the diploid. The stomata and palisade cells were larger in the tetraploid. The length of the guard cells of stomata of the diploid and the tetraploid was 20.03 microns and 25.87 microns, respectively. The number of stomata and epidermal cells per unit area was more in the case of the diploid. The tetraploid shoots started flowering a little later than the diploids. The tetraploid shoots were characterised by larger flowers in comparison with the diploid (Plate I). The average diameter of the pollen grains was more in the induced tetraploid. The pollen fertility, as judged by their stainability with acetocarmine, was lower in the tetraploid. Although there was not much difference in the fruit-setting of the diploid and the tetraploid, the seed-setting was, however, slightly lower in the tetraploid.

The pollen mother cells of the untreated plants showed nine bivalents at diakinesis (Fig. 1) and metaphase I. The anaphase I showed

equal distribution of chromosomes at the two poles. The haploid chromosome number of nine for *Torenia fournieri* Lind., as revealed by the present studies, is in conformity with an earlier report<sup>1</sup> on the chromosome number of this plant. The haploid chromosome number of the tetraploid shoots was found to be eighteen. A number of pollen mother cells of the tetraploid showed 18 bivalents at diakinesis (Fig. 2).



PLATE I. Flowers of diploid (left) and the induced tetraploid (right).



FIGS. 1 2. Fig. 1. Diakinesis of the diploid showing 9 bivalents,  $\times 1,000$ . Fig. 2 Diakinesis of the induced tetraploid showing 18 bivalents,  $\times 1,000$ .

A few of the pollen mother cells showed multivalents. The meiosis, in general, in the induced tetraploid showed abnormalities like the presence of univalents at diakinesis and

the unequal distribution of chromosomes at anaphases.

The presence of large flowers on the tetraploid shoots of *Torenia fournieri* is indicative of the possibility for the isolation of a type with large flowers.

We are grateful to Prof. P. Maheshwari, Head of the Department of Botany, University of Delhi, for the facilities and encouragement.

Department of Botany, S. L. TANDON.  
University of Delhi, KAMLESH BHUTANI.  
Delhi-6, August 14, 1964.

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#### GERMINATION OF *RAUWOLFIA SERPENTINA* BENTH. SEEDS

THE main problem in raising the plants of *Rauwolfia serpentina* through seeds is the germination of the latter. Santapau<sup>1</sup> has stated that it appears from the reports from many parts of India that the percentage of germination of seeds of *Rauwolfia serpentina* is about 10 which is the usual one obtained in most parts of the country. The author while experimenting with the irradiated seeds of this plant obtained encouraging results in respect of germination.

Dry seeds of *Rauwolfia serpentina* Benth. were irradiated with a series of gamma-ray doses ranging from 2,500 r to 15,000 r at the Atomic Energy Establishment, Trombay. The irradiated seeds were immediately sown in pots along with untreated seeds acting as control. The observations on germination of the seeds indicated that the irradiation helped in increasing the percentage of germination from 20.5 in control to 74.5 and 73 in seeds with dosages, 2,500 r and 5,000 r respectively. As the irradiation dosage was increased further the rate gradually declined and it was 57.5% in seeds with dosage 15,000 r (Table I).

TABLE I

Effect of gamma radiation on germination of *Rauwolfia serpentina* seeds

	Radiation Dose						
	Control	2,500 r	5,000 r	7,500 r	10,000 r	12,500 r	15,000 r
% Germination	20.5	74.5	73	65.6	59.5	58.5	57.5

It may be stated that the Rongo Experimental Station, West Bengal, and the Research Stations of the Forest Department, Bombay and

Bhadwar,<sup>2</sup> obtained successful germination even up to 50% in *Rauwolfia serpentina* seeds. However it will be seen from the results by the author that irradiation of seeds at 2,500 r can raise the percentage of germination up to 74.5 by breaking the dormancy of seeds.

The author desires to express his gratitude to Dr. V. R. Dnyansagar for guidance.

Department of Botany, S. G. TORNE.  
Institute of Science,  
Bombay-1, October 17, 1964.

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#### AVAILABILITY AND UPTAKE OF PHOSPHORUS BY WHEAT UNDER DIFFERENT MOISTURE AND ORGANIC MATTER LEVELS

A GREEN-HOUSE experiment was conducted on several soils with wheat as a test crop to study the fixation, availability and uptake of soil and fertilizer phosphorus at different levels of moisture and organic matter. Radioactive super-phosphate at an activity of 0.15 mc./g.  $P_2O_5$  was used to supply a basal dose of 80 lb.  $P_2O_5$ /acre. Three levels of organic matter (0, 10, 20 tons/acre) and 4 levels of moisture (100, 150, 125, 175%) were combined in a randomized design with 3 replications.

Observations on yield of dry matter, uptake of total soil and fertilizer phosphorus have been recorded at three stages—30 days, 53 days and 71 days after germination. This last date, which corresponded to flowering stage, was when the crop was finally harvested.

The results obtained indicate that the yield of dry matter, uptake of total and soil phosphorus (including the contribution from organic matter) increased with increase in organic and moisture levels. The percentage uptake and utilization of fertilizer phosphorus decreased with organic matter in all soils except in Koilpatti where an increase in uptake and utilization of fertilizer phosphorus was noticed with increase in organic matter. The highest uptake of fertilizer phosphorus was found at moisture levels 100 to 125% in all soils. Organic matter increased the available phosphorus content in all soils while higher moisture levels were found to decrease it. The percentage phosphorus-fixation capacity decreased with increase in O.M. and moisture levels.

College of Agriculture,  
Banaras Hindu University,  
Varanasi-5, December 10, 1964.

K. K. Vyas.

## REVIEWS

Chemie im Dienst der Archäologie Bautechnik Denkmalpflege. By von J. Arvid Hedvall, mit Beiträgen von Gunnar Degelius und Hjalmar Granholm. (Akademiförlaget-Gumperts, Göteborg), 1962. Pp. x + 229. Price not given.

The author of this work is Professor Emeritus for Silicate Chemistry at the Chalmers Technische Hochschule at Göteborg, in Sweden and is well known for his investigations on the solid state. The present work is intended to stress the importance of a knowledge of chemistry and of the structure of solids in the conservation of archaeological buildings and monuments. There are chapters in the book dealing with the necessity of such knowledge, the existing provision for archaeological studies in various countries, the description of stones and working materials, on the structure of solids, the various causes of decay of such materials, and finally on the question of restoring and conserving monuments. As could have been expected from the standing of the author, this is a work of high merit. It is richly illustrated with numerous photographs and figures and will greatly interest all those concerned in the preservation of ancient buildings and monuments.

C. V. R.

Numerical Analysis (Second Edition). By Zdenek Kopal. (Chapman and Hall Ltd., London), 1961. Pp. 594. Price 70 sh.

The author of this book is Professor of Astronomy at the University of Manchester and is well known for his studies on close binary systems in astronomy. A treatise by him with the latter title was published by M/s. Chapman and Hall Ltd. in 1959. All who are familiar with dynamical astronomy are aware that it is a severe mathematical discipline in which numerical computations figure prominently. It is therefore not surprising that Prof. Kopal is deeply interested in numerical techniques. A treatise by him on that subject necessarily commands respect and attention.

The first edition of the book under review was published in the year 1955. That a second edition has been called for within five years is a tribute to its excellence. As was explained in the preface to the first edition, the aim of the work was to provide an advanced under-

graduate text-book as well as a research hand-book for certain branches of numerical analysis. The appearance of the second edition has been utilised to give some account of more recent developments in the field, including especially the systematic application of operational calculus to numerical analysis.

The chapter headings give an indication of the contents of the treatise: I. Introduction; II. Polynomial Interpolation; III. Numerical Differentiation; IV. Integration of Ordinary Differential Equations; V. Boundary-Value Problems: Algebraic Methods; VI. Boundary-Value Problems: Variational, Iterative, and other Methods; VII. Mechanical Quadratures; VIII. Numerical Solution of Integral and Integro-Differential Equations and IX. Operational Methods in Numerical Analysis. Five Appendices follow.

The book is an authoritative presentation of a highly important field in practical mathematics and should be most welcome to teachers and students alike.

C. V. R.

Progress in Protozoology. (Published jointly by the Czechoslovak Academy of Sciences, Prague, and by the Academic Press of New York and London), 1963. Pp. 623. Full page plates 105 nos.

The volume under review is a report of the Proceedings of the First International Congress on Protozoology held at Prague from August 22 to 31, 1961. The Congress was attended by 140 men of science from many different countries apart from Czechoslovakia. The scientific proceedings are reported under eight different headings, viz., Taxonomy, Genetics, Biochemistry, Biophysics, Cytology, Ecology, Toxoplasmosis and Electron Microscopy of the Protozoa, besides a ninth concluding section on Parasitic Protozoa. Nineteen communications appear in the first section, six in the second section, thirty-one in the third, fourteen in the fourth, nineteen in the fifth section, fifteen in the sixth section, nine in the seventh section, twenty in the eighth and not fewer than fifty-six in the concluding section. The contents are fully indexed and the volume is superbly illustrated with not fewer than 103 full-page plates.

The scientific editor of the volume was Academician Otto Jirovec of Prague, who was

also the Chairman of the Organizing Committee of the Congress. He was assisted by three other editors, viz., J. Ludvik, J. Lom and J. Vavra, also protozoologists at Prague.

In view of its extensive scientific coverage, the volume will be warmly welcomed by protozoologists all over the world.

C. V. R.

**The Internal Constitution of the Stars.** By Sir A. S. Eddington, with a new introduction by Lloyd Motz. (Dover Publications, Inc., New York). Pp. 1-407. Price Two Dollars and Twenty-five cents.

**Radiative Transfer.** By S. Chandrasekhar. (Dover Publications, Inc., New York). Pp. 1-393. Price Two Dollars and Twenty-five cents.

These are unabridged reprints of well-known works, which no student of astronomy or astrophysics can afford to do without or leave unread. Printed on excellent paper and bound firmly in such manner as not to come apart, they make it possible to acquire at a modest price classical treatises which have made scientific history.

C. V. R.

**Solar and Aeolian Energy—Proceedings of the International Seminar on Solar and Aeolian Energy held at Sounion, Greece, September 4-15, 1961.** Edited by Admiral A. G. Spanides and A. D. Hatzikakidis. (Plenum Press, New York), 1964. Pp. ix + 491. Price \$17.50.

This Seminar was started immediately after the United Nations Conference in Rome in August 1961. It may be thought that the two meetings being held very close to each other there would be many repetitions in the *Proceedings*. But a perusal of the contents would show it to be otherwise. There were 54 lectures given in all and the *Proceedings* present a thorough and comprehensive review of the different techniques which may be useful for the exploitation of solar and wind energy over a wide area, both technical and geographical.

The papers on the use of solar energy for obtaining drinkable or distilled water from the sea or brackish water give a complete picture of the present literature. The techniques to increase the daily yields have to be improved. The problem still remains open and surveys must be continued. There have been some papers on solar heaters and the production of high temperatures with solar energy. Materials to make these are costly and especially the materials for mirror surfaces. Simpler equip-

ment for cooking have not yet reached the expected efficiency. Some of the papers deal with the cooling devices using solar heat. Two important papers relate to the great advances made in solar cells to produce electricity with solar energy. At present their cost of production is high.

There were a number of papers on the exploitation of sunlight biologicals and it seems algæ and other kinds of chlorellas will give considerable help in producing protein food in the future.

On the subject of aeolian energy, there were 10 lectures. There has been considerable discussion as to whether large or small units are superior. All the same, there is a general conviction that wind power exploitation promises much for the future. Some of the problems relate to the storage of the produced power, because aeolian energy cannot be used at any time, but only when we find it.

The *Proceedings* of the Seminar are a significant contribution towards understanding the technological applications of uniquely economical and abundant natural power sources.

S. P. VENKITESHWARAN.

**Progress in Organic Chemistry, Vol. 6.** Joint Editors: Sir James Cook and W. Carruthers. (Messrs. Butterworth & Co. Ltd., 4 and 5, Bell Yard, London W.C.-2), 1964. Pp. 256. Price 57 sh. 6 d.

During the past two decades new areas of interest have grown in organic chemistry and progress in them has been very rapid. Original publications are on the increase necessitating periodic reviews of the progress achieved from time to time. Thus alone can the general student of chemistry, as well as the specialists in particular fields, keep abreast of the subject as a whole. In this respect the volumes published by Butterworths in their Progress Series play a very useful role.

The publication under review, which is the sixth in the series, contains six review articles by authors who have themselves made substantial contributions to the topics they have reviewed thus making them authoritative. Four of these articles are on the chemistry of natural products, the fifth one is on a subject of profoundly growing interest in organic chemistry, namely Carbenes, and the last one is a physico-organic topic dealing with molecular orbitals.

The chemical processes involved in the conversion of animal skins into leather by the action of vegetable tannins are of great

theoretical as well as industrial importance. Haslam and Haworth in the article on Vegetable Tannins discuss recent advances with special reference to their structural characteristics and biosynthesis. Bisbenzylisoquinolines are plant alkaloids many of which possess an unusual 18-membered heterocyclic system. Historically, the chemical interest in these alkaloids can be traced back to the arrow poison, curare, extracted from wourali root, and used by South American Indians. Grundon in his survey article on these alkaloids gives an account of the recent progress made in their studies by discussing in detail the chemistry of some typical compounds of this class.

Polyacetylenes are another group of natural products characterized by chains of conjugated triple bonds. Recently several polyacetylenes have been isolated from plant sources used for flavouring. It will be interesting to study if the triple bonds confer flavours on them. In his article on this subject Bu'Lock surveys the different classes of natural acetylenes against a background of biogenetic considerations. The chemistry of the phenoxazones has acquired an added interest recently through the discovery of several groups of natural products which contain a phenoxazone ring as chromophore. Schafer in the article on the chemistry of phenoxazones gives an account of their syntheses, properties and reactions.

As mentioned earlier an area of organic chemistry which is experiencing a tremendous growth and wide interest is the Carbene chemistry. Carbenes (methylene), often previously considered as diradicals, are now recognized as a new type of intermediate in organic interactions. They are very reactive compounds and undergo a variety of addition and insertion reactions. Kirmse's review of the present state of carbene chemistry "may help to activate future efforts in this field". There is a bibliography of 275 references (up to end of 1962) at the end of this article.

In the last article Mason gives an account of progress which has been made in the application of molecular orbital theory to organic equilibria and reaction rates taking some typical compounds as examples.

A. S. G.

*Treatise on Analytical Chemistry, Part II, Vol. 6.*  
Edited by I. M. Kolthoff and Philip J. Elving.  
(Interscience Publishers, John Wiley & Sons, Inc., 605, Third Avenue, New York-16, New York). Pp. 627. Price \$23.

The chief aim of the publishers in bringing out this many-volume reference work has

already been emphasised when we had occasion to review in these columns the previous volume that had been issued in this series. That aim, in brief, is to make available to working analytical chemists a comprehensive source book in which they can readily obtain 'definitive' information regarding all aspects of classical and modern analytical chemistry.

The elements dealt with in this volume and the authors who have contributed are as follows: *Beryllium* (pages 1-68) by B. R. F. Kjellgren, C. W. Schwenzfeier, Jr., and E. Stanley Melick; *Lead* (pages 69-176) by T. W. Gilbert, Jr.; *Niobium and Tantalum* (pages 177-406) by Silve Kallmann; *Technetium* (pages 407-434) by James W. Cobble; and *Actinium, Astatine, Francium, Polonium and Protactinium* (pages 435-610) by Jacob Sedlet.

The contents under each element have been systematically arranged and cover all ranges of study including historical, occurrence, production and properties, compounds—inorganic and organic—their preparation, separation, analysis, detection, identification and estimation, etc. The analytical treatment is exhaustive and critical, and references to literature are extensive. Apart from being an invaluable guide to all analytical chemists the book contains material which will stimulate further research.

A. S. G.

*Physical Methods in Organic Chemistry.* Edited by J. C. P. Schwarz. (Oliver and Boyd, Edinburgh and London), 1964. Pp. 350. Price 50 sh.

The book, written by eight teachers, presents the several physical methods that have come into vogue in the study of the structures and properties of organic compounds. The introductory chapter, by the editor, presents the historical background, and a good survey of the methods in which, apart from the principles and applicability to problems, the approximate cost of apparatus, their maintenance, availability, set-up, etc., have all been discussed.

The topics dealt with are the ultra-violet, visible, infra-red and Raman spectroscopy (P. Bladon and G. Eglinton); magnetic resonance spectroscopy, n.m.r. and e.s.r. (L. M. Jackman); optical rotation (J. C. P. Schwarz); diffraction methods, X-ray (G. A. Sim); mass spectrometry (R. I. Reed); dipole moments (C. T. Greenwood). The instruments and the basic principles are a little too briefly described, but the chapters are directed particularly towards the interpretation of instruments' data by the chemist, and in that sense it is a very useful,

ly practical text-book. One of the interesting aspects of this book is that many illustrative experimental data have been obtained specially for the book by the authors themselves in their laboratories. Lucid examples of applications reveal the scope of the methods.

The printing is clear and there are numerous blocks, figures and tables which add to the clarity of the textual matter. The book will be highly useful to post-graduate students as well as teachers in our universities.

G. B.

**The Transfer of Calcium and Strontium Across Biological Membranes—Proceedings of a Conference held at Cornell University, Ithaca, New York, May 13-16, 1962.** Edited by R. H. Wasserman. (Academic Press, Inc., III, Fifth Avenue New York-3), 1963. Pp. xvii+443. Price \$11.50.

Since many of the membrane functions appear to be associated with specialized regions of the cell membrane which occupy a very small fraction of the total area, the problem of interpretation of results pertaining to the transport across the membranes is greatly complicated. 'Fundamentals of ion transfer across membranes' reviews some of the properties of the biological membranes and discusses the general aspects of ion transport and chelation of divalent cations.

'Physiological aspects of intestinal absorption' presents various techniques for studying ion transfer across the alimentary tract. These studies reveal the discrimination in absorption of strontium *vis a vis* calcium and emphasizes the danger of generalization, since transport appears to vary, both qualitatively and quantitatively, with the species of animal and techniques used.

The role of vitamin D in the intestinal absorption of calcium, the importance of the interrelationship between Ca and P in their metabolism and the adaptation to alterations in calcium intake are well brought out in 'Nutritional considerations of intestinal absorption'.

The chapters on the 'Chemical properties of phosphopeptides and their possible role in the intestinal absorption of metals', 'The significant role of lactose in enhancing absorption and utilisation of calcium' and 'Transfer of calcium and strontium across the cells of the kidney, mammary gland, nerve and muscle' comprehensively review the recent developments in the interrelationship and metabolic behaviour of calcium and strontium.

M. SIRSI.

**A Dictionary of Scientific Units** (including dimensionless numbers and scales). By H. G. Jerrard and D. B. McNeill. (Chapman & Hall, Ltd., 37, Essex Street, London W.C.-2), 1963. Pp. 197. Price 21 sh.

This useful publication should be handy to every science student and teacher of science. With the present intense specialization in various fields of science new units and nomenclature have come to be used which though very familiar to workers in the discipline concerned are, in many cases, quite foreign to those belonging to a different discipline. Units like Reynolds' number and Prandtl number in fluid mechanics, Rad, Rem and Rep as applied to irradiation doses, Fermi, Chad and Rutherford in atomic physics, and Phon and Rayl in sound, have become part of scientific literature. This dictionary is just designed to be a quick reference to obtain all necessary information on the scientific units that are in current use throughout the world. An important feature of the book is the list of about 500 references to original literature on units which will be useful to inquiring students.

#### Books Received

**Physical Techniques in Biological Research** (Vol. 5)—*Electro-Physiological Methods* (Part A). Edited by W. L. Nastuk. (Academic Press, Inc., 111, Fifth Avenue, New York 10003), 1964. Pp. xv + 460. Price \$16.00.

**A Course of Mathematics for Engineers and Scientists** (Vol. 5). (Pergamon Press, Headington Hill Hall, Oxford), 1964. Pp. viii + 202. Price 25 sh.

**Heat Engines and Applied Thermodynamics.** By N. C. Dey. (Asia Pub. House, Calicut Street, Ballard Estate, Bombay-1), 1964. Pp. xv + 443. Price Rs. 26-00.

**Advances in Pharmaceutical Sciences.** Edited by H. S. Bean, A. H. Beckett and J. E. Carless. (Academic Press, Berkeley Square House, London W.-1), 1964. Pp. xi + 334. Price 75 sh.

**Automatic Control.** By C. R. Webb. (McGraw-Hill Pub. Co. Ltd., Shoppenhangers Road, Maidenhead, Berks.), 1964. Pp. xi + 297. Price 42 sh.

**Introduction to Quantum Mechanics.** By P. T. Matthews. (McGraw-Hill Pub. Co. Ltd., Shoppenhangers Road, Maidenhead, Berks.), 1964. Pp. xii + 170. Price 25 sh.

**Deccan College Monograph Series** (No. 27)—*Process of Speech.* By C. R. Sankaran. (Deccan College Post-Graduate and Research Institute, Poona-6), 1963. Pp. 76. Price Rs. 15-00.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

Banaras Hindu University has awarded the Ph.D. degree in Metallurgy to Shri P. Rama Rao for his thesis entitled "Studies in X-ray Line-Broadening in Metals and Alloys".

Andhra University has awarded the Ph.D. degree in Physics to Sri J. Ramakrishna for his thesis entitled "On Certain Theoretical and Experimental Investigations on Nuclear Quadrupole Resonance in Solids".

M.S. University of Baroda has awarded the Ph.D. degree in Chemistry to Shri K. P. Mathai for his thesis entitled "Studies in Phenols and Biphenols"; Ph.D. degree in Botany to Shri Rameshwar Prasad Garga for his thesis entitled "Studies on Some Plant Viruses and Virus Diseases of Plants in Madhya Pradesh".

Osmania University has awarded the Ph.D. degree in Technology to Shri M. K. H. Siddiqui for his thesis entitled "Studies on Activation of Earths for Bleaching Mineral and Vegetable Oils using Conventional and Fluidization Methods and Optimisation of Activation Conditions by Differential Thermal Analysis"; Ph.D. degree in Physics to Shri V. G. Krishna Murthy for his thesis entitled "Temperature Dependence of the Photoelastic Behaviour of Crystals".

### Neurosecretory Cells in *Dysdercus*

Shri D. P. Gupta, Department of Zoology, University of Saugar, M.P., India, writes:

Studies on neurosecretory cells in *Dysdercus koenigii* Fabr. (Cotton bug) have brought out some interesting points which are presented below:

Neurosecretory cells were seen in the pars intercerebralis medialis on either side of the fissure of the protocerebrum. In *Dysdercus* the cells are arranged in medial and lateral groups. There are usually 6-8 median neurosecretory cells in each lobe of the protocerebrum. The two lateral cells lie just above the antennary lobe. One or two ventral neurosecretory cell(s) are seen in the middle of the tritocerebrum.

In nymph, four or five pairs of medial neurosecretory cells are present in the posterior side of the protocerebrum. In the adult male and female *Dysdercus* the position of the pars intercerebralis medialis cells is a little variable. In male adult insect, these cells are towards the posterior side of the protocerebrum. On the

contrary the pars intercerebralis medialis cells in the females are located towards the anterior side of the protocerebrum. In other words we can say that in the adult females these cells migrate towards the anterior dorsal side of the protocerebrum, while the position of these cells in the male adult remains the same as in the nymphs.

### Results of Stratoscope II, the Balloon-Borne Telescope

The results of the studies made from the Stratoscope II on its November 1963 flight have been reported by the sponsors of the flight—Princeton University, Office of Naval Research, and the National Aeronautics and Space Administration (NASA). Major scientific data on celestial objects is being gathered by the 3-ton Stratoscope II, balloon-borne telescope, launched to 80,000-foot altitude. The telescope's 36-inch aperture quartz mirror weighs 400 pounds, is 5½ inches thick and is polished to an accuracy of 1/2,500,000 of an inch.

Data confirmed the existence and measured the effect of water vapour in the atmosphere of cool red giant stars. The water vapour absorbs large sections of the radiation emitted by the stars while permitting the remainder of the infra-red radiation to pass through from star surface to outer space. In addition to six cool red giant stars observed on the flight, the Stratoscope II telescope observed the moon, Jupiter, the two hot stars Sirius and Aldebaran. This is the first time that the moon's reflectivity has been accurately measured in the infra-red spectrum.

Other scientific results of the flight included the indication that the amount of interstellar ice-gains in space may have been overestimated and the confirmation of previous observations that methane and ammonia are the major constituents of Jupiter's atmosphere.—(Bull. Amer. met. Society, 1964, 45, 591.)

### Crab Nebula and the Neutron Star Hypothesis

The neutron star hypothesis (see Curr. Sci., August 20, 1964) for the origin of galactic X-rays seems to have received a set-back by a recent observation to verify its validity. Two strong sources of X-radiation in the sky were reported by Prof. H. Friedman who used rocket-borne detection devices. One is in the

vicinity of the constellation of Scorpius, and the other coincident with the Crab nebula.

The experiments that disproved the existence of a neutron star at the centre of the Crab nebula was conducted on July 5, 1964 by Friedman *et al.* On that day the Crab nebula was due to be occulted by the moon—a rare event that will not recur again until 1972. An Aerobee rocket bearing X-ray sensitive detectors was fired from the White Sands Missile Ranges at precisely 3:42.5 P.M. just as the nebula began to pass behind the edge of the moon. If the neutron star hypothesis were correct, the X-ray source would have disappeared abruptly within one or two seconds of arc. Instead the X-ray intensity dwindled during the five-minute occultation in proportion to the nebular surface blacked out by the moon. The source appears to be an extended region—about one light-year across near the centre of the nebula. The nebula itself is six light-years in diameter. Crude spectral measurements indicated that the temperature in this region may be higher than 10 million degrees K.—(*Scientific American*, September 1964.)

#### Wind Velocity Measurements by Using Sonic Waves

A communication by G. Kelton and P. Bricout in the *Bulletin of the American Meteorological Society* (September 1964) describes a new technique of measuring the velocity and direction of wind at ordinary anemometer heights, about 70 ft., by using a directed beam of sonic waves as the probe and observing the Doppler frequency shift in the scattered sonic waves. The technique is unique in the sense that it does not involve any local sensor, artificial target, or structure erected over the ground.

The basic principle of the experiment may be stated thus: A sonic beam at a given frequency is directed toward a point in space which consists of volume elements  $\Delta v$  carried by the wind. The Doppler shift frequency received by these elements is re-radiated (scattered) and a new Doppler shift frequency is received at the receivers. The wind velocity is obtained by measuring the Doppler shift experienced between the frequency emitted by the source and that obtained at the receivers. Arrangements were made for continuous recording of the received signals.

The source in the experiment is a powerful Levavasseur whistle used at about 10 kc. mounted at the focus of a 4-ft. diameter parabolic reflector (1.5 ft. focus). This produced a peak sound intensity of 110 db (10 mw per sq. ft.) at a distance of 70 ft. The two receivers, placed in orthogonal directions with respect to the source, consisted of highly sensitive and stable piezoelectric type ceramic microphones, also mounted at the focus of 4-ft. parabolic reflectors.

The series of over 300 sonic measurements on winds from 3 to 25 mph show good agreement between sonic speed measurement and anemometer measurements: it was within  $\pm 1$  mph for speed and  $\pm 5^\circ$  for direction. The method is likely to give valuable turbulence information in addition to wind velocity data.—(*Bull. Amer. Met. Soc.*, 1964, 45, 571.)

#### Bacterium to Fix Atmospheric Nitrogen for Jute Crop

A bacterium (*Beijerinckia acida*) which can be employed to fix atmospheric nitrogen for a jute crop grown on land of subnormal fertility has been successfully isolated by the Jute Agricultural Research Institute of the Indian Central Jute Committee.

Field experiments at JARI have shown that the nitrogen-fixing activity of the bacterium is assisted by the application of sodium molybdate.

The use of seeds treated with the bacterial culture, together with a basal dressing of sodium molybdate at the rate of 4 kg. per hectare, has been found to increase the yield of Tossa jute (*C. oliterius*) by 7 to 24% in fields where no other fertilizer or manure was applied.

#### The IV International Photobiology Congress

The Fourth International Photobiology Congress was held in Oxford from July 26th to 30th, 1964. The Congress was sponsored by the Comité International de Photobiologie (CIP) which is composed of affiliated National Groups of Associations. The Congress brought together workers in different disciplines, interested in the effect of ionising and non-ionising radiation on biological systems, for discussions of their overlapping problems. The recently formed Indian Photobiology Group (Chittaranjan National Cancer Research Centre, Calcutta) received its affiliation to C.I.P. in this Congress.